

# Onan

## Service Manual

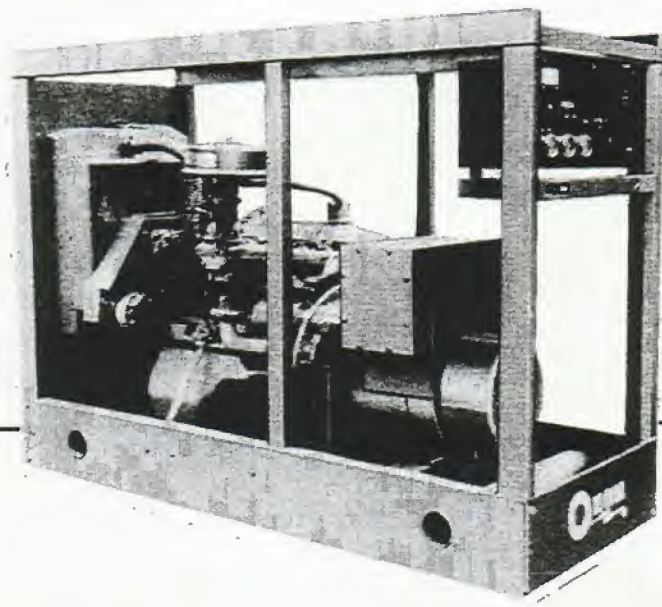
30 kW

SK SERIES

DC Controls

**Supplement to YD  
Generator and Controls  
Service Manual 900-0184**

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**900-0328**

8-81 (Replaces  
900-0218 4-79)  
Printed in U.S.A.

# Safety Precautions

The following symbols in this manual highlight conditions potentially dangerous to service personnel, or equipment. Read this manual carefully. Know when these conditions can exist. Then take necessary steps to protect personnel as well as equipment.

**WARNING** *Onan uses this symbol throughout this manual to warn of possible serious personal injury.*

**CAUTION** *This symbol refers to possible equipment damage.*

## PROTECT AGAINST MOVING PARTS

Avoid moving parts of the unit. Avoid use of loose jackets, shirts or sleeves due to danger of becoming caught in moving parts.

Make sure all nuts and bolts are secure. Keep power shields and guards in position.

If you must make adjustments while the unit is running, use extreme caution around hot manifolds, moving parts, etc.

Do not work on this equipment when mentally or physically fatigued.

## GUARD AGAINST ELECTRIC SHOCK

Disconnect electric power before removing protective shields or touching electrical equipment. Use rubber insulative mats placed on dry wood platforms over floors that are metal or concrete when around electrical equipment. Do not wear damp clothing (particularly wet shoes) or allow skin surfaces to be damp when handling electrical equipment.

Disconnect batteries to prevent accidental engine start. Jewelry is a good conductor of electricity and should be removed before working on electrical equipment.

Use extreme caution when working on electrical components. High voltages cause injury or death.

Follow all state and local codes. To avoid possible personal injury or equipment damage, a qualified electrician or an authorized service representative must perform installation and all service.

## WARNING

### ENGINE EXHAUST GAS (CARBON MONOXIDE) IS DEADLY!

*Carbon monoxide is an odorless, colorless gas formed by incomplete combustion of hydrocarbon fuels. Carbon monoxide is a dangerous gas that can cause unconsciousness and is potentially lethal. Some of the symptoms or signs of carbon monoxide inhalation are:*

- Dizziness
- Intense Headache
- Weakness and Sleepiness
- Vomiting
- Muscular Twitching
- Throbbing in Temples

*If you experience any of the above symptoms, get out into fresh air immediately.*

*The best protection against carbon monoxide inhalation is proper installation and regular, frequent inspections of the complete exhaust system. If you notice a change in the sound or appearance of exhaust system, shut the unit down immediately and have it inspected and repaired by a competent mechanic.*



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**WARNING**

**ONAN RECOMMENDS THAT ALL SERVICE INCLUDING INSTALLATION OF REPLACEMENT PARTS ONLY BE DONE BY PERSONS QUALIFIED TO PERFORM ELECTRICAL AND/OR MECHANICAL SERVICE. FROM THE STANDPOINT OF POSSIBLE INJURY AND/OR EQUIPMENT DAMAGE IT IS IMPERATIVE THAT THE PERSON BE QUALIFIED.**



# DC Control Operation

## GENERAL

The descriptions in this section are limited to the exterior and interior DC components of the control panel.

Refer to the Operator's Manual 946-0120 for installation, engine operation and general maintenance data.

Refer to engine manufacturer's manual for engine repair and servicing information.

## CONTROL PANEL EXTERIOR

The following is a brief description of the DC controls and instruments located on the face of the control panel, Figure 1.

### DC Panel

**Oil Pressure Gauge:** Indicates lubricating oil pressure (wires to a sensor unit located on the engine).

**Water Temperature Gauge:** Indicates temperature of engine coolant (wired to a sensor unit on the engine).

**DC Ammeter:** Indicates battery charging current.

**Running Time Meter:** Registers total unit run time in hours to the 1/10th. Time is cumulative, meter cannot be reset.

**Run-Stop-Remote Switch:** Starts and stops unit locally or allows operation from a remote location.

**Reset Switch:** Manual reset for engine monitor after an engine shutdown.

**Fault Light:** Indicates a "fault" in engine operation.

## OPTIONAL EQUIPMENT

### DC Panel

**Warning Lights:** Individual indicator lights give warning of:

- Overcrank (failure to start) (O.C.)
- Overspeed (O.S.)
- Low oil pressure (LOP)
- High engine temperature (HET)
- Low engine temperature (LET)

## CONTROL PANEL INTERIOR

The components discussed in this section should only be adjusted, tested, or replaced by a qualified

service representative. The panel interiors for the one- and five light control panels are shown in Figure 2.

Figure 3 shows schematic arrangements of the one-light and the five-light 12 VDC control circuits.

**Engine Monitor and Shutdown Modules:** Printed circuit plug-in modules provide the following functions:

1. A 75-second cranking period.
2. Approximately a 12-second time delay for oil pressure build up.
3. An external alarm contact to light the fault lamp and shut down the set for malfunctions such as:
  - a. Overcrank—failure to start after the 75 second cranking period.
  - b. Low oil pressure—14 psi (97 kPa).
  - c. Overspeed—approximately 2100 r/min.
  - d. High engine temperature—215°F (102°C).

On standard control panels all four alarms are wired into one common fault lamp. Diagnostic light emitting diodes for overcrank, low oil pressure, and high engine temperature are provided on the front of the module cover panel, inside the control panel. If an engine malfunction shutdown occurs (fault lamp illuminated), and none of the diagnostic diodes are illuminated, then the shutdown is due to an overspeed condition.

On optional control panels a fault lamp is provided for each malfunction shutdown. A fifth fault lamp is also provided for low engine temperature, although there is not an engine shutdown associated with it.

## OPTIONAL MODULES

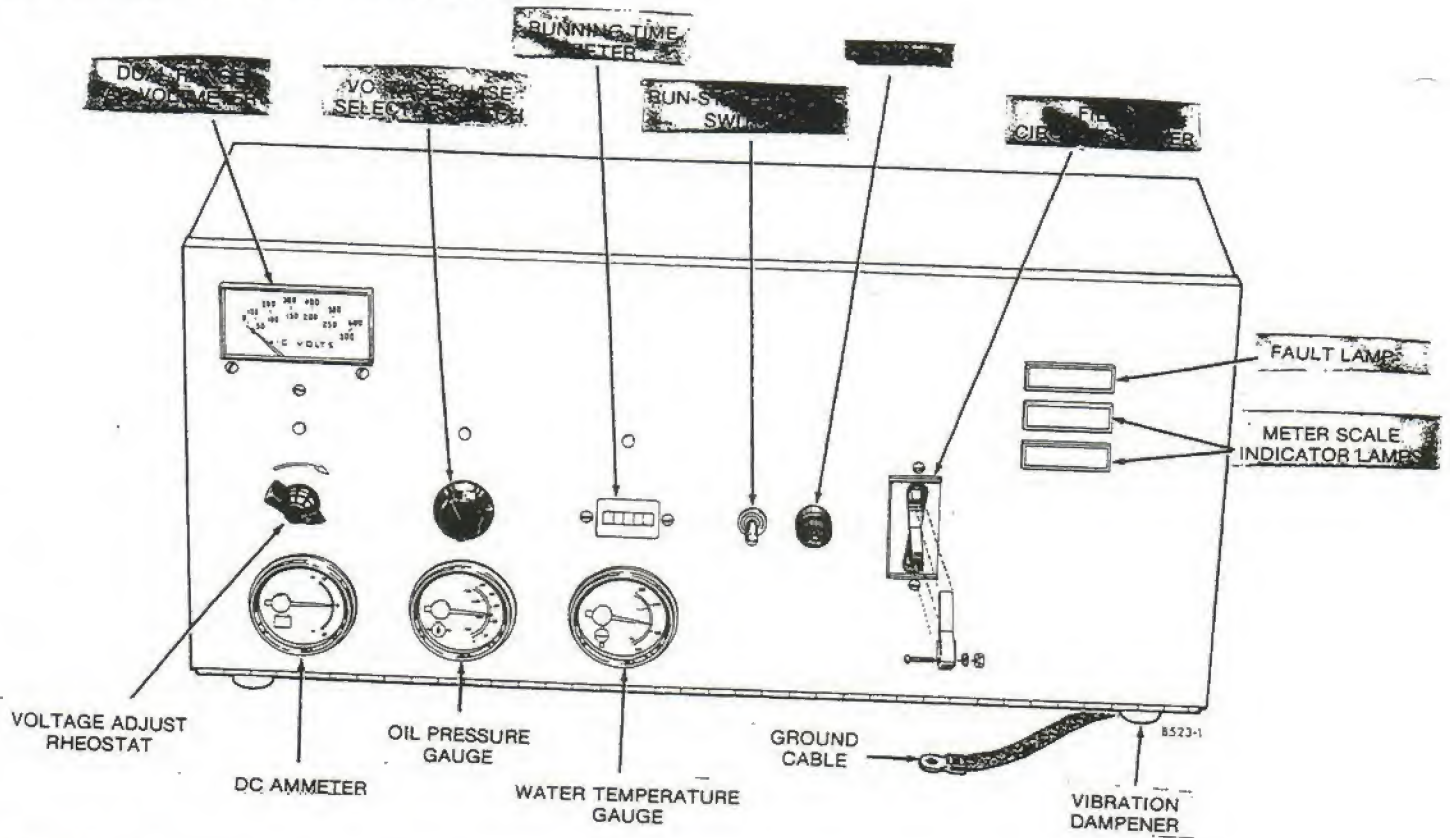
**Start Disconnect Module:** Used with a magnetic pickup sensor that senses and sends engine speed to the Start Disconnect module and the overspeed circuit. This plug-in module operates at about 100 r/min. above maximum cranking speed to prevent energizing of starter while engine is running.

**Cycle Cranker:** A plug-in module replacing the standard cranking circuit. This module provides a 15-second crank time and a 10-second rest period alternately for three On and two Off cycles in 65 seconds. If the engine does not start within 75 seconds, the engine monitor lights a fault lamp and opens the cranking circuit.

**Time Delay Start/Stop Module:** A plug-in module used only in remote start applications. Provides 1 to 10 seconds time delay on starting and 30 seconds to 5 minutes time delay on stopping. The delay periods are adjustable on the module front.



## STANDARD ONE-LIGHT METER PANEL



## OPTIONAL FIVE-LIGHT METER PANEL

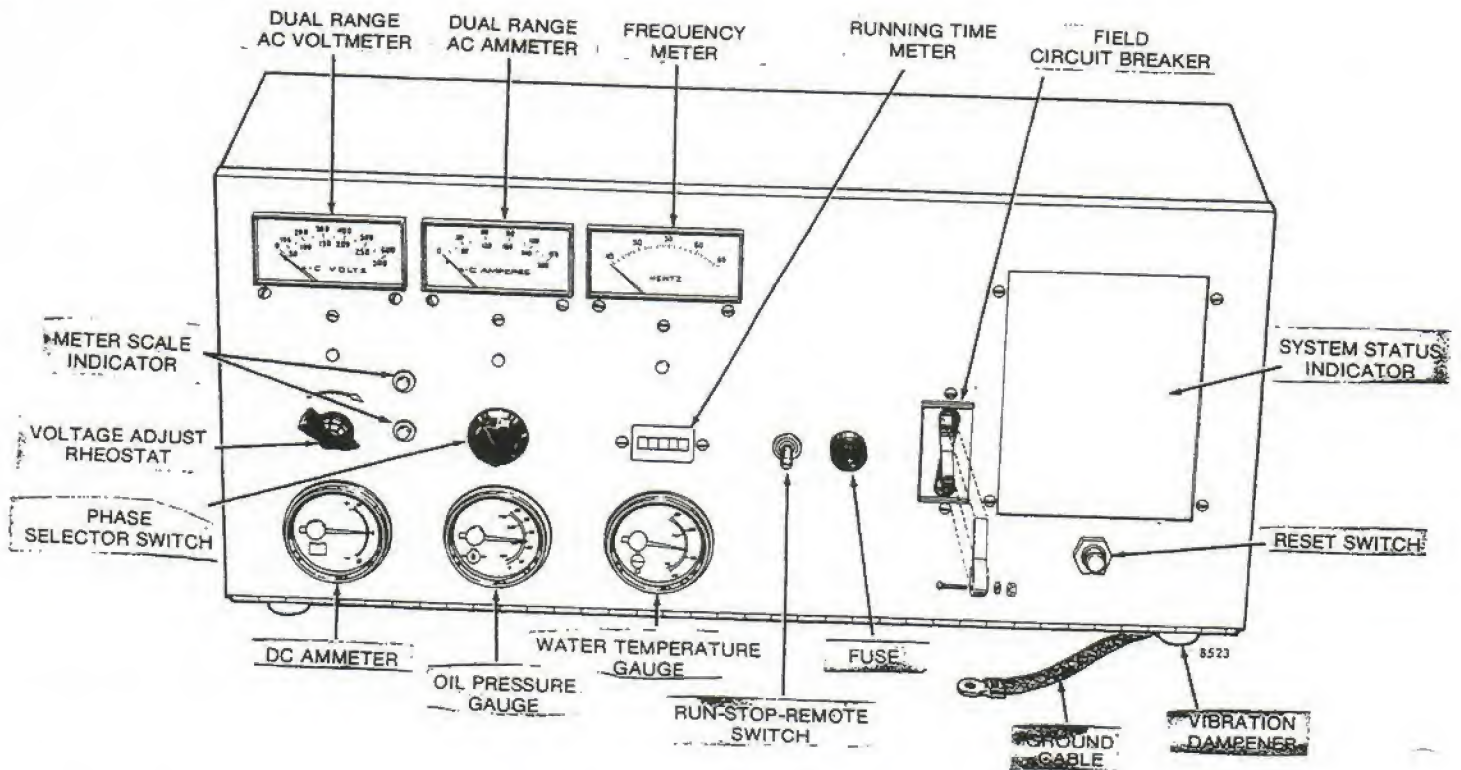
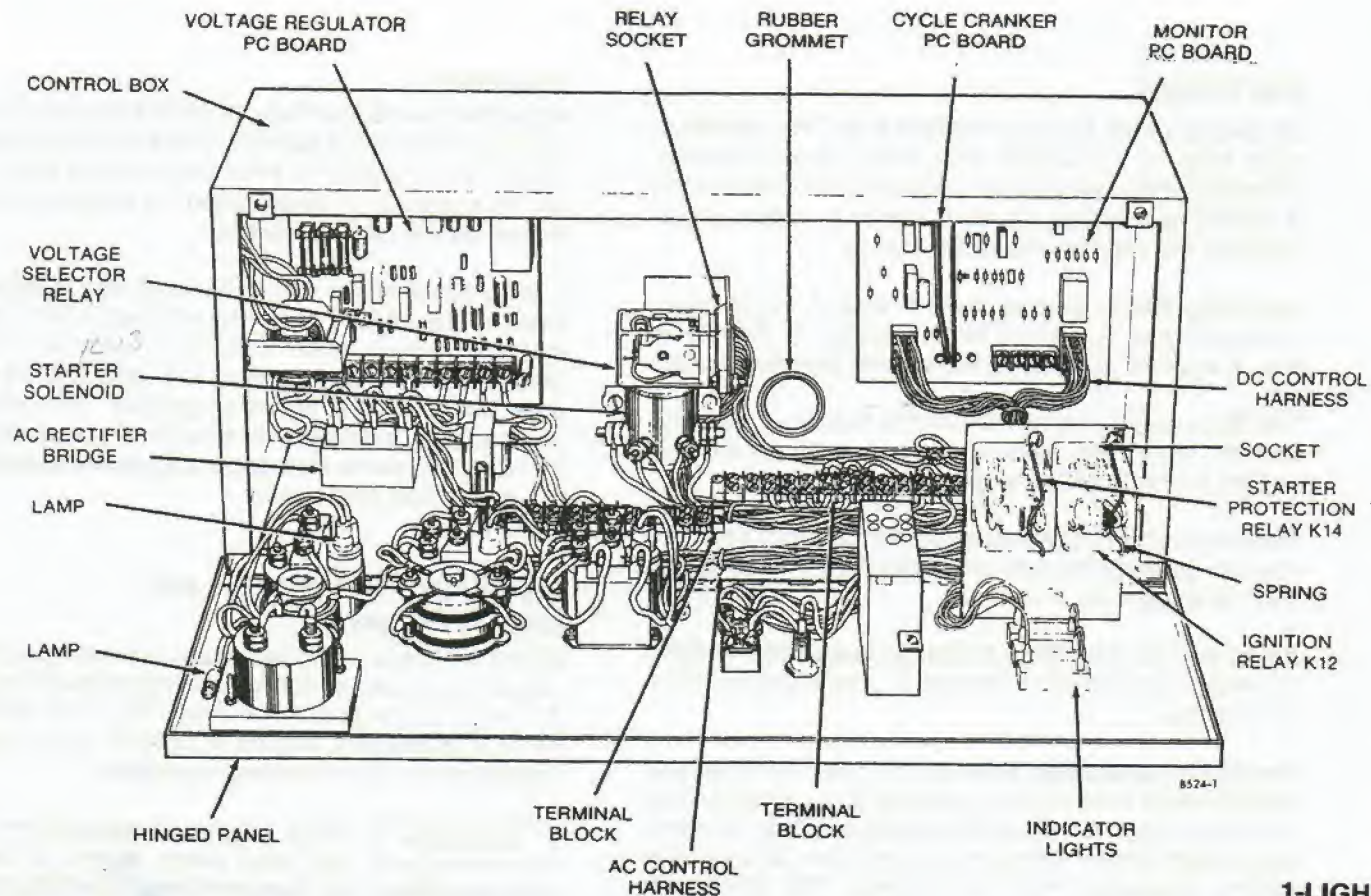


FIGURE 1. CONTROL PANEL FACES





1-LIGH

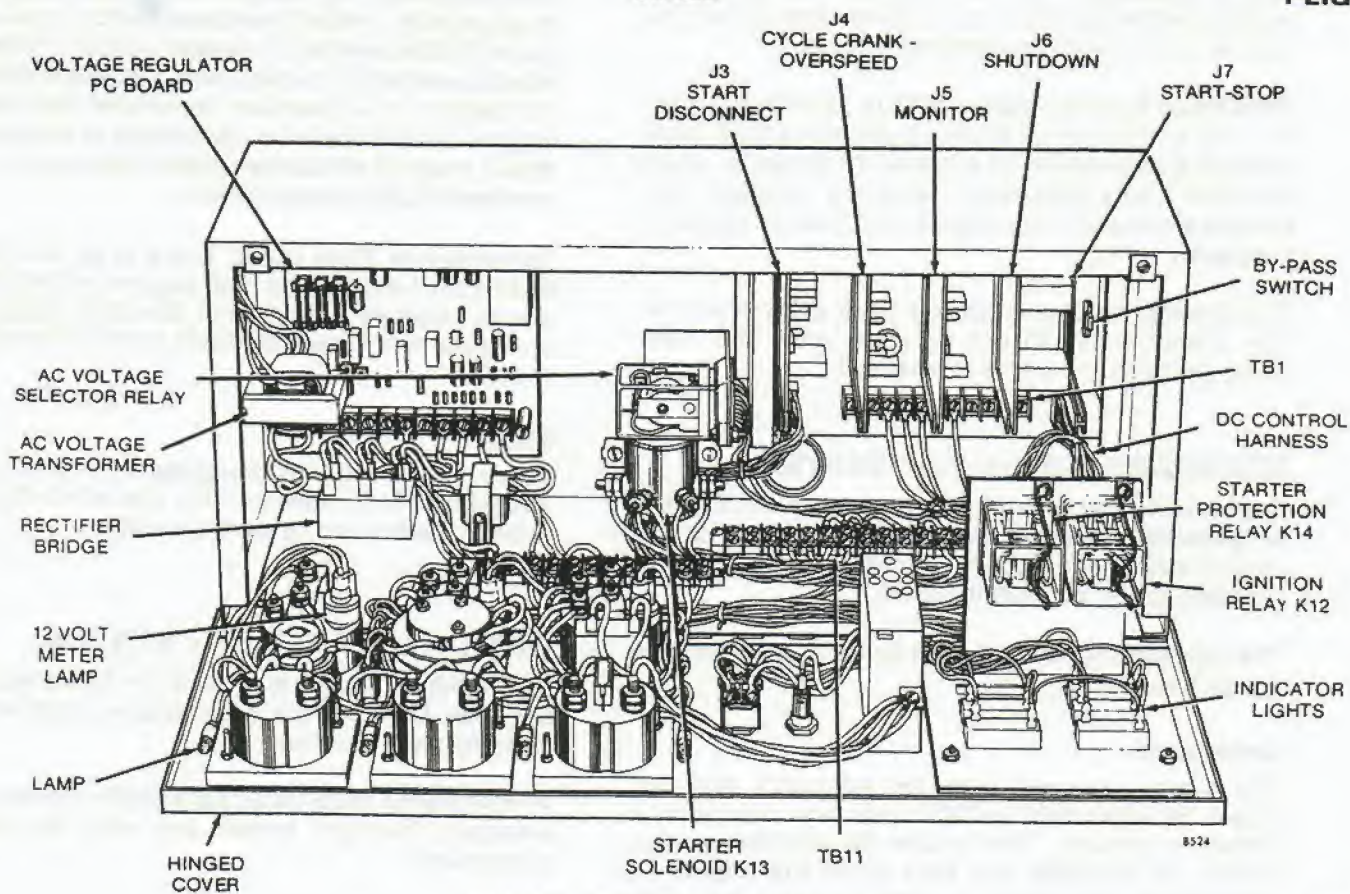


FIGURE 2. CONTROL PANEL INTERIORS

5-LIGH



## SWITCHES

**Cycle-Standard Cranker Switch S12:** This switch is used only in the single fault lamp control panels. When the optional cranker module is used, the switch is positioned to the Cycle Cranker position which disables the standard cranker circuit.

**Run-Stop/Reset-Remote Switch S15:** A single-pole, double-throw, center-off toggle switch. In Run position, it applies 12 VDC to the engine monitor board.

The Stop position shuts down the engine. This position on one-light systems allows relay(s) on the engine monitor board to de-energize.

Remote position allows engine starting from a remote station. Closing the remote station switch applies 12 VDC to the proper circuits.

**Reset Switch S14 (Five-Light System):** This switch, located on the front control panel, resets and tests the fault lamps.

**Pre-Alarm Shutdown Switch S11:** Used on five-fault lamp control and all Pennsylvania State models. The Pre-alarm position gives the operator advance warning of high engine temperature and low oil pressure before shutdown level is reached. The Shutdown position will shut down the engine when either the HET or LOP pre-alarm switches operate.

**Time Delay By-Pass Switch S12:** In Time Delay position, the switch allows engine to start on a time delay basis (0.5 seconds to 10 minutes 15 seconds) when the Time Delay Start/Stop module is installed. This module also delays the engine shutdown by the same time span.

The Bypass position removes time delay features. This position should not be used when the Time Delay Start/Stop module is installed.

## STANDARD, ONE-LIGHT SYSTEM

A one fault lamp is standard equipment on 30.0 kW SK generator sets. The lamp indicates a fault for any engine malfunction. Refer to the one-light troubleshooting guide for fault location.

The following functions relate to the Engine Monitor circuit board A11:

### Overspeed

The overspeed switch on the generator end bell closes between 2000 to 2200 r/min. and completes a circuit to ground. This allows the shutdown relay A11-K1 to energize and shut down the engine by interrupting the circuit to ignition relay K12. The shutdown relay energizes the external alarm circuit and de-energizes the low oil pressure, high engine temperature, and overspeed circuits (Figure 3).

### Overcrank

When the Run-Stop-Remote (R-S-R) switch is in Run position, the engine starts to crank and the overcrank circuit is energized. The maximum crank time (nominal 75 seconds) is determined by integrated circuit timers on the monitor board.

If the engine starts within 75 seconds, voltage supplied by the battery charging alternator will energize start-disconnect relay K11. The overcrank timer is disabled and prevents engine shutdown. If the engine does not start, K11 is not energized. The overcrank timer circuit conducts to energize shutdown relay A11-K1. The same sequence occurs as described for the overspeed shutdown.

## High Engine Temperature and Low Oil Pressure

Either of these switches when closed completes a circuit to ground which will energize shutdown relay A11-K1 (12.5 second time delay for LOP). When the relay is energized, engine shutdown is the same as described for an overspeed condition.

**CAUTION** *High Engine Temperature Cutoff will shut down engine in an over-heat condition only if coolant level is sufficiently high to physically contact shutdown switch. Loss of coolant will allow engine to overheat without protection of shutdown device, thereby causing severe damage to the engine. It is therefore imperative that adequate engine coolant levels be maintained, to ensure operational integrity of cooling system and engine coolant overheat shutdown protection.*

**Pennsylvania State Units:** There is no shutdown or fault lamp indication for high engine temperature and low oil pressure. When S2 or S6 close, relay A11-K2 energizes and closes contacts to the external alarm circuit.

### Reset

Relay A11-K1 remains energized as long as 12 VDC is available to it. To reset A11-K1, place R-S-R to STOP, then to the desired operating position.

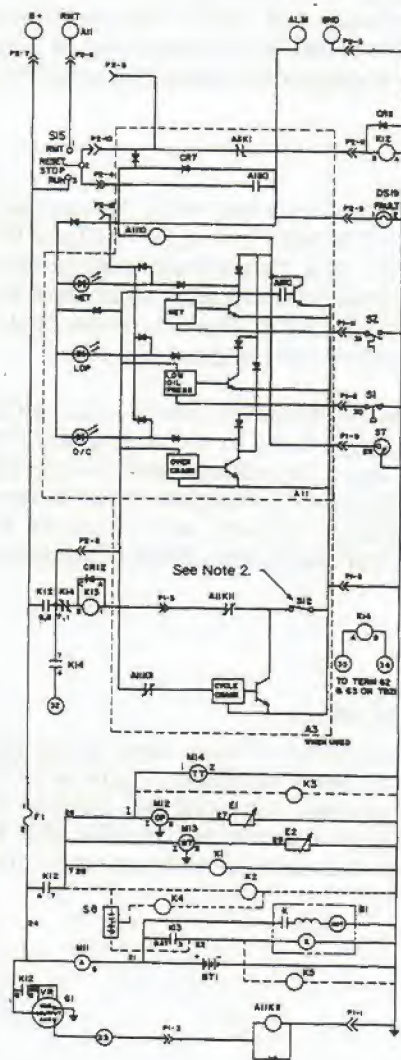
## OPTIONAL FIVE-LIGHT SYSTEM

The five-light system is optional on SK series generator sets. Refer to the appropriate troubleshooting chart for fault location.

**Pennsylvania State Units:** Essentially the same as the standard five-light system but with the following exceptions:

1. No pre-alarm switches.
2. High engine temperature, alarm and light only. No engine shutdown.





### 1-FAULT LAMP

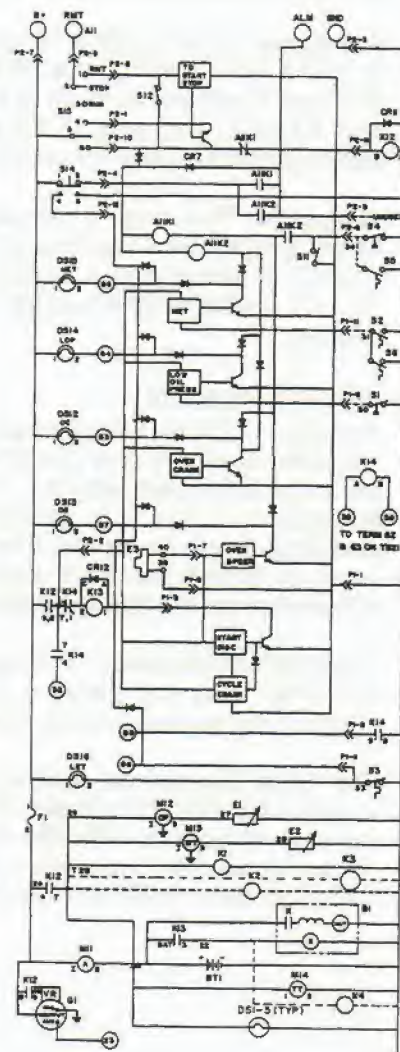
SEE DWG. 612-5473 SHEET 2  
FOR WIRING DIAGRAM

LEGEND	
REF. DES.	DESCRIPTION
B1	Starter and Solenoid - Eng
BT1	Battery - 12 V
E1	Sender - Oil Pressure
E2	Sender - Water Temp
E3	Sender - Speed (Mag)
G1	Alternator and Regulator
K1	Solenoid - Fuel
K2	Solenoid - Water
*K4,K5	Solenoid, Gas
S1	Switch - Low Oil Pressure Pre-Alarm
S2, 6	Switch - Hi Eng Temp Pre-Alarm
S3	Switch - Low Eng Temp
S4	Switch - Low Oil Pressure
S5	Switch - Hi Eng Temp
S7	Overspeed Switch (1-light)
A11	Control - Box Module - Start Disc Module - C/C, O/S Module - Monitor Module - Shut Down Module - Start-Stop
A12	Panel - Fault Light
CR11	Diode
CR12	Diode Assy
DS1-3	Lamp - Pilot
DS4,5	Lamp
DS12-16	Light - Ind (Fault)
F1	Fuse - 5 Amp
K12	Relay - Ignition (12 V)
K13	Relay - Start Solenoid (12 V)
K14	Relay - Starter Protection (240 V)
M11	Ammeter - Charge
M12	Gauge - Oil Pressure
M13	Gauge - Water Temp
M14	Meter - Running Time
R22	Resistor Assy
S8	Switch-Vacuum (1-light)
S12	Cranker Bypass (1-light)
S12	Time Delay Bypass
S14	Switch - Reset
S15	Switch - Selector R-S-R
TB11	Terminal Board

\*K4 ON 612-5473 IS GAS SOLENOID

### NOTES:

1. ALL COMPONENTS SHOWN IN DE-ENERGIZE POSITION.
2. S12 ON ONE-LIGHT IS CLOSED FOR STANDARD CRANKER. OPEN S12 WHEN A3 CYCLE CRANKER IS USED.
3. COMPONENTS CONNECTED BY DASHED LINES ARE OPTIONAL.



### FIVE-FAULT LAMPS

SEE DWG. 612-5433 SHEET 2  
FOR WIRING DIAGRAM

FIGURE 3. 12 VDC ENGINE CONTROL SCHEMATICS



3. Low Oil Pressure, alarm and light only. No engine shutdown.
4. Low Engine Temperature, light only.
5. Engine shutdown on Overcrank or Overspeed only. Use standard five-light troubleshooting guides.

### High Engine Temperature

This fault indication system operates in two steps, pre-alarm and shutdown. See Figure 3.

**Pre-Alarm:** When engine temperature reaches 200° to 210°F (93° to 99°C) the HET pre-alarm switch S2 or S6 will complete a circuit to energize the fault lamp and A11-K2. Contacts of K2 energize the external alarm circuit and arm K1 shutdown relay.

**Shutdown:** The engine temperature switch closes when temperature reaches 210° to 220°F (99° to 104°C). It completes a circuit to energize A11-K1. The K1 contacts de-energize K12 to shutdown the engine.

### Low Oil Pressure

Pre-alarm LOP switch S1 closes at 18 to 22 psi (124 to 152 kPa) completing a circuit which lights the fault lamp and energizes relay K2. The contacts of K2 arm K1 shutdown relay and energize the external alarm circuitry. There is a short time delay (nominal 12.5 second) before the fault lamp and K2 energize to allow oil pressure build up when starting the engine.

The LOP cut-off switch S4 closes at 12 to 16 psi (83 to 110 kPa). This completes a circuit to energize K1, causing the engine to shut down.

The Start Disconnect module prevents the engine monitor from shutting down the engine on LOP during start sequence. After the engine starts, there is a 10 to 15 second time delay in the LOP shutdown circuit to allow build up to normal pressure.

### Overcrank

This circuit allows a maximum engine crank time of 70 to 80 (nominal 75) seconds, regardless of the mode of operation of the Cycle Cranker module. If the engine does not start within 75 seconds, the overcrank circuit will complete a circuit for A11-K1 (shutdown relay). When energized, A11-K1 NC contacts open to de-energize K-12 (ignition relay), shutting down the engine.

If the engine starts before 75 seconds of cranking, the Start Disconnect module will inhibit the overcrank shutdown circuit. The start-disconnect circuit prevents starter motor engagement while the engine is running.

### Overspeed

Engine speed is detected by a magnetic pickup sensor and coupled to the monitor board. At 2010 to 2190 (nominal 2100) r/min. the Overspeed module provides the signal necessary for circuitry to actuate the ground path for relay A11-K1. The K1 contacts de-energize K12 to shutdown the engine.

The overspeed sensor is mounted near the top center of the flywheel housing, close to the ring gear. The magnetic pickup sensor generates electrical pulses as the ring gear teeth pass it. The generated pulses, proportional to engine speed, are coupled by two wires to the Overspeed and Start-Disconnect circuits.

### Low Engine Temperature

The Low Engine Temperature fault lamp is on any time the engine temperature is below a nominal 65°F (18°C). After engine start, the light will remain on until engine temperature reaches 80° to 90°F (27° to 32°C). There is no alarm or shutdown with this circuit.



# Control Troubleshooting

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The data in this section will help the technician to quickly restore a set to service. The information is in the following formats:

- A five-light system Checkout using the Onan Tester Module part number 420-0388.
- A quick-check chart for one-light and five-light systems.
- Seven troubleshooting flow charts referenced to trouble symptoms.

## PREPARATION

Before going on a service call, take along spare printed circuit boards and relays for the set being repaired. A set of fully charged batteries can be an aid for starting the generator set and removed later if necessary. Remember, it may be very important to restore operation in minimum time.

Before starting a troubleshooting procedure, make a few simple checks that may expose the problem and cut down service time.

- Check all modifications, repairs, replacements

performed since last satisfactory operation of set. A loose wire connection overlooked when installing a replacement part could cause problems. An incorrect connection, an opened switch or circuit breaker, or a loose plug-in are all potential problems that can be eliminated by a visual check.

- Unless absolutely sure that panel instruments are accurate, use portable test meters for troubleshooting.

To use the Checkout and Flow Charts, start at the upper-left corner of chart and answer all questions either YES or NO. Follow the chart until the problem is found, performing referenced Test Procedures following the charts on page 24. Refer to typical wiring diagrams for locating control component leads, terminals and other check points.

Referenced battery B+ voltage measurements are to common ground unless stated otherwise.

The one-light control uses relay A11-K11 in the start-disconnect circuit while the five-light control uses a start-disconnect module. The five-light control also has an overspeed control module. Otherwise, the two control circuits are very similar.

# ONE-LIGHT CONTROL SYSTEM CHECKOUT

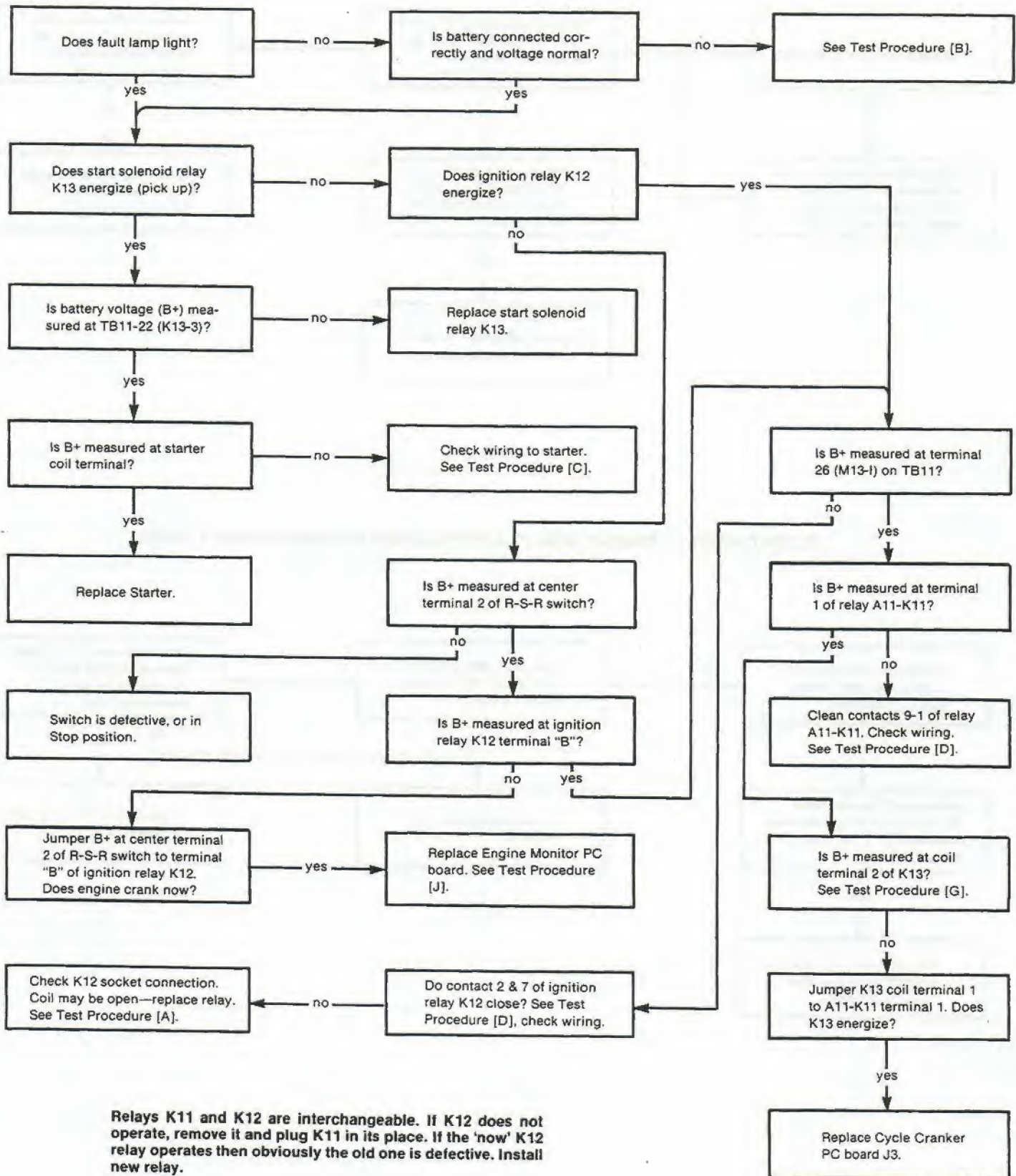
## QUICK CHECK

SYMPTOM	CORRECTIVE ACTION
1. Engine stops cranking and fault lamp lights after cranking approximately 75 seconds. Overcrank diagnostic LED (DS2) lit.	1. Check fuel supply and ignition systems. See engine manual. Check operation of carburetor choke solenoid (units so equipped).
2. Fault lamp lights immediately after engine starts. None of the the diagnostic LED's illuminated.	2. Check for overspeed condition as the engine starts.
3. Fault lamp lights and engine shuts down after running for a period. Check for lighted diagnostic LED's.	3. Observe and check the following: a. Low Oil Pressure LED (DS1) lit; check oil level, engine will shut down if sensor is closed. Check Chrysler manual for troubleshooting oil system. b. High Engine Temperature LED (DS3) lit; check coolant level, coolant flow (city water cooled systems), check radiator for free air flow, fan belts for tightness. See engine manual for troubleshooting cooling system. c. Check for faulty oil pressure or high engine temperature sensor.
4. Fault lamp lights, none of the diagnostic LED's lit, no fault exists.	4. Disconnect leads from TB11 terminals 29, 30, and 31. If fault lamp lights with leads disconnected and no diagnostic LED's are lit, replace engine monitor board. Reconnect leads.

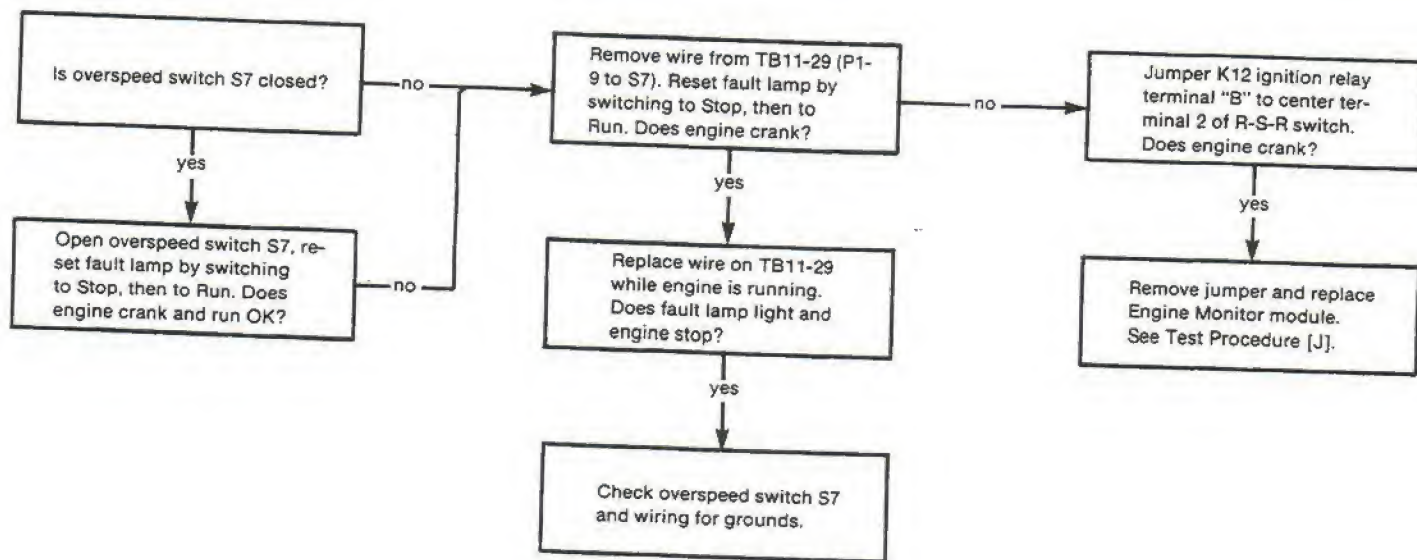


# **FLOW CHART A. ENGINE FAILS TO CRANK. SWITCH IN RUN POSITION.**

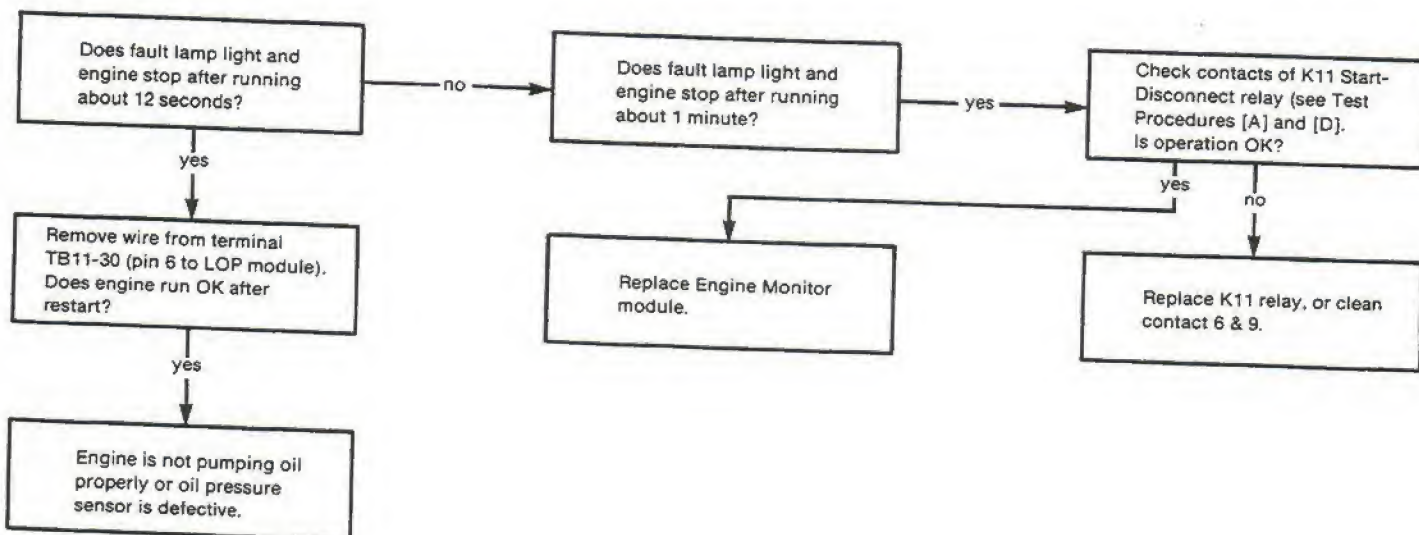
**NOTE:** Place R-S-R switch in Run position when making voltage measurements.



# **FLOW CHART B. ENGINE SHUTS DOWN IMMEDIATELY AFTER START.**



# **FLOW CHART C. ENGINE SHUTS DOWN AFTER RUNNING SHORT TIME.**





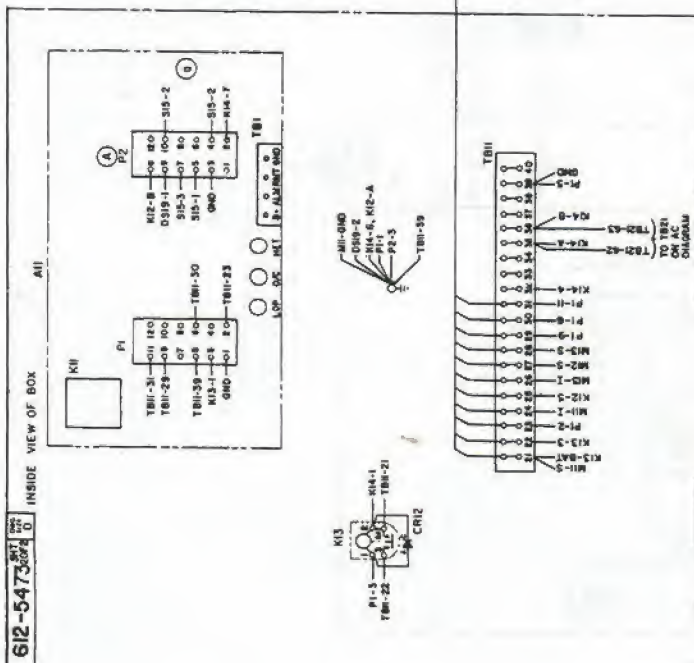
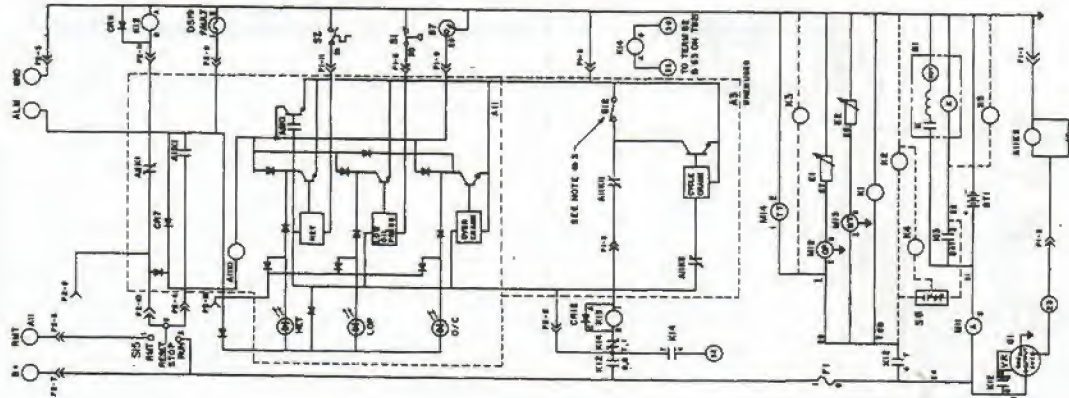
PARTS LIST		
REF. DES.	QTY.	DESCRIPTION
B1		STARTER AND SOLENOID - ENG
BT1	1	BATTERY-12V
E1	1	SENDER-OIL PRESSURE
E2	1	SENDER-WATER TEMP
G1	1	ALTERNATOR AND REGULATOR
K1	1	SOLENOID-FUEL
K2	1	SOLENOID-WATER
K3,4	2	SOLENOID-GAS (WHEN USED)
K5	1	SOLENOID-CHOKE
S1	1	SWITCH-LOW OIL PRESS
S2	1	SWITCH-HI OIL TEMP
S7	1	ILLUS-OVERSPEED SW MTG
S8	1	SWITCH-VACUUM (WHEN USED)
CONTROL BOX PARTS LIST		
A11	1	CHASSIS-MONITOR BOARD
A3	1	MODULE-CYCLE CRANKER
CR11	1	DIODE
CR12	1	DIODE ASSY
DS19	1	LIGHT-INDICATOR (FAULT)
DS4	1	LAMP-BULB
F1	1	FUSE - 5 AMP
K12	1	RELAY-IGNITION (12V)
K13	1	RELAY-START SOLENOID (12V)
K14	1	RELAY-STARTER PROTECTION (240V)
K11	1	RELAY-START DISCONNECT (12V)
M11	1	AMMETER-CHARGE
M12	1	GAUGE-OIL PRESSURE
M13	1	GAUGE-WATER TEMP
M14	1	METER-RUNNING TIME
R22	1	RESISTOR ASSY
S15	1	SWITCH-SELECTOR
TB11	1	MARKER STRIP

NOTES:  
1. COMPONENTS CONNECTED WITH DASHED LINES ARE OPTIONAL ITEMS

2. REMOTE ALARM CIRCUIT RATED 5 AMP MAX.

3. S12 CLOSED FOR STANDARD CRANKER. WHEN A3 CYCLE CRANKER IS USED, OPEN S12.

4. UNLESS OTHERWISE NOTED, ALL COMPONENTS SHOWN HAVE IDENTIFIED POSITION.



REAR VIEW OF PANEL

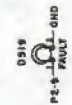
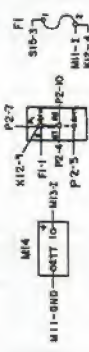
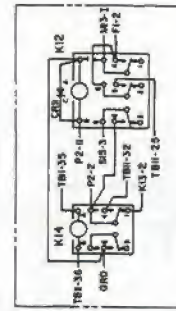
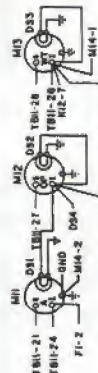
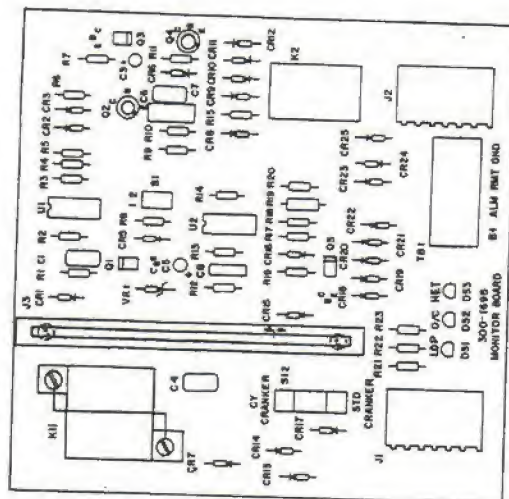


FIGURE 4. ONE-LIGHT 12 VDC CONTROL SCHEMATIC AND WIRING DIAGRAM (612-5473)

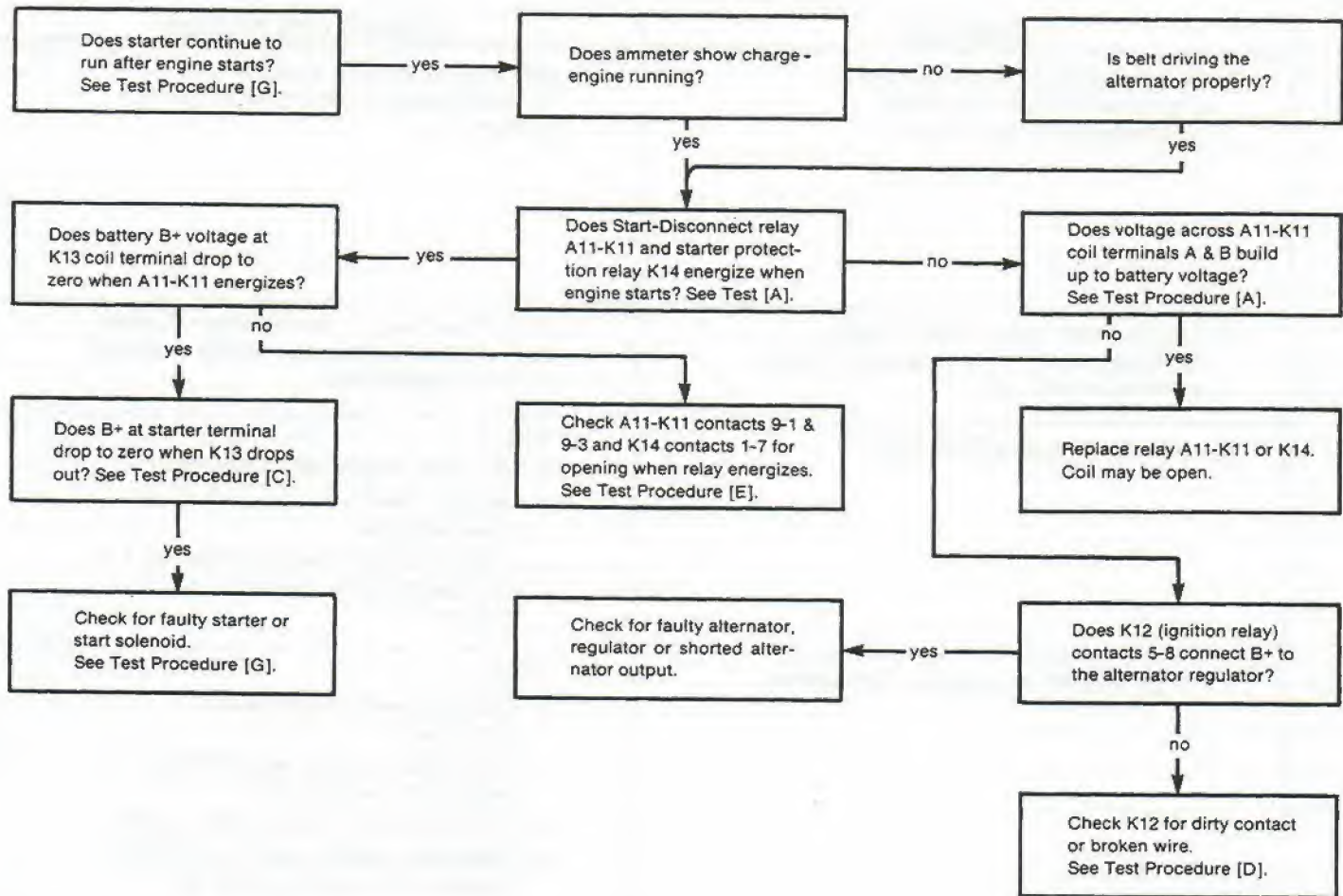
3-B-CYCLE CRANK  
300-1604



**FIGURE 5. ONE-LIGHT CONTROL—2 WIRE START (625-1543)**



# FLOW CHART D. STARTER FAILS TO DISENGAGE, OR TRIES TO RE-ENGAGE WHILE RUNNING.





# FIVE-LIGHT CONTROL SYSTEM CHECKOUT

## QUICK CHECK

SYMPTOM	CORRECTIVE ACTION
1. Overcrank fault lamp lights and engine stops cranking after approximately 75-seconds.	1. See engine service manual for troubleshooting fuel system, ignition system, etc.
2. Engine runs, shuts down, cranks for 75-seconds, cranking cycle stops, overcrank light ON.	2. Check fuel supply and ignition. Check operation of carburetor choke solenoid (units so equipped).
3. Low oil pressure shutdown.	3. Check — a. Oil level. Replenish if necessary. b. Sensor. Faulty sensor will shut down engine. c. Refer to engine service manual for troubleshooting guide for oil system.
4. High engine temperature shutdown.	4. Check— a. Coolant level. Replenish if necessary. b. City water cooled sets. Check water flow, valves, etc. c. Check sensor; check thermostat. d. Radiator model, check fan belts, radiator for obstructions, etc.
5. Overspeed shutdown.	5. Check governor and throttle linkages for freedom of movement. Replace module J4.
6. Low oil pressure light ON. No shutdown.	6. Disconnect wire at TB11-30. Light On after relay reset—replace Engine Monitor module J5.
7. High engine temperature light ON. No shutdown.	7. Disconnect wire at TB11-31. Light On after relay reset—replace Shutdown Monitor module J6.



## Checkout Using Onan Control Tester Module

This procedure is for use with the Engine Control Tester module, Onan part number 420-0388. The Tester Module is designed for making final pre-start system tests to check out the complete control system for rapid location of faults.

### Proceed as follows:

1. Remove front cover of engine module rack.

2. Remove T.D. Start-Stop module J7.

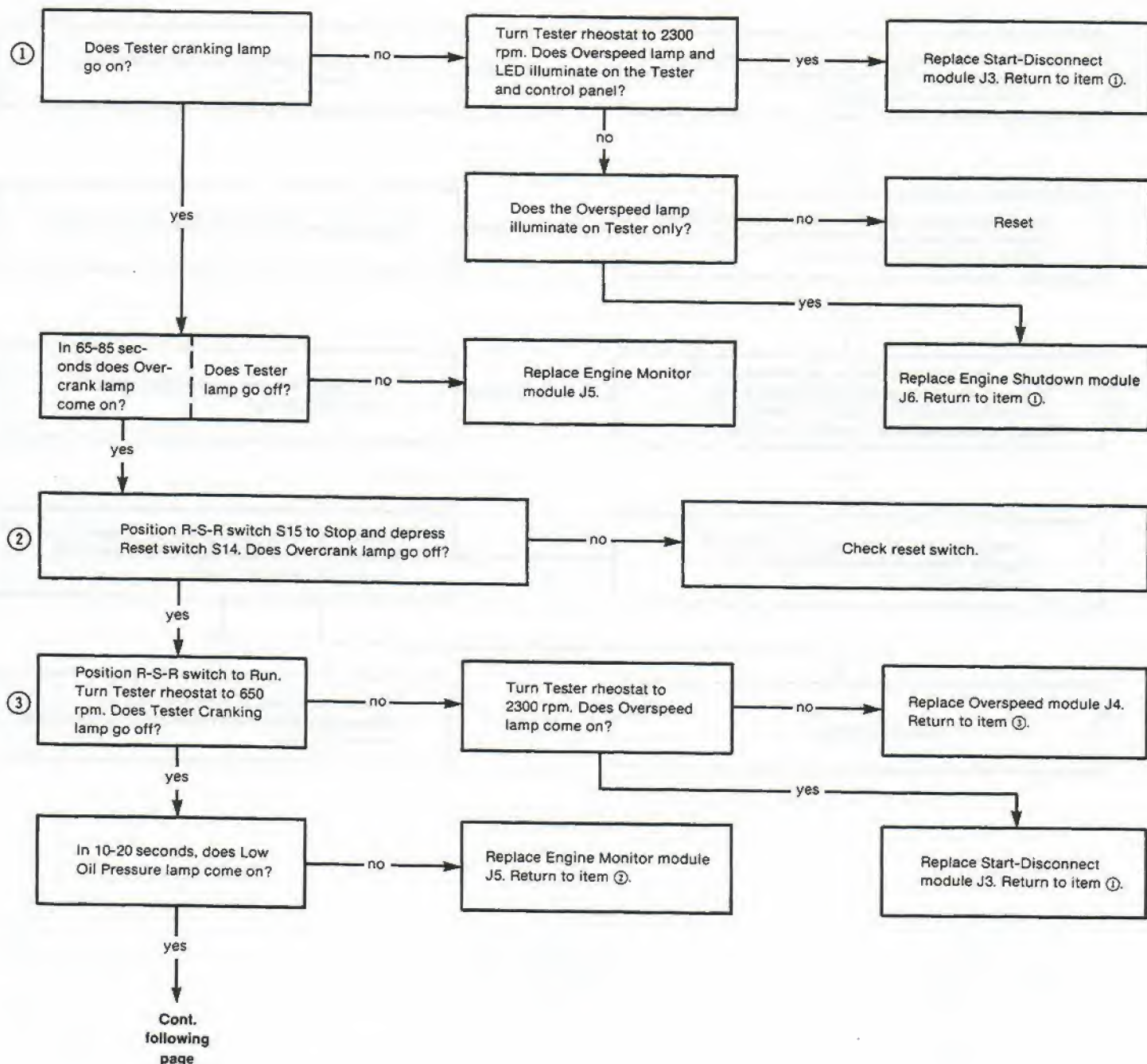
3. Insert Engine Control Tester module into T.D. Start-Stop module J7.

4. Remove Starter Protection Relay K14.

5. Set rheostat on Tester module full counterclockwise.

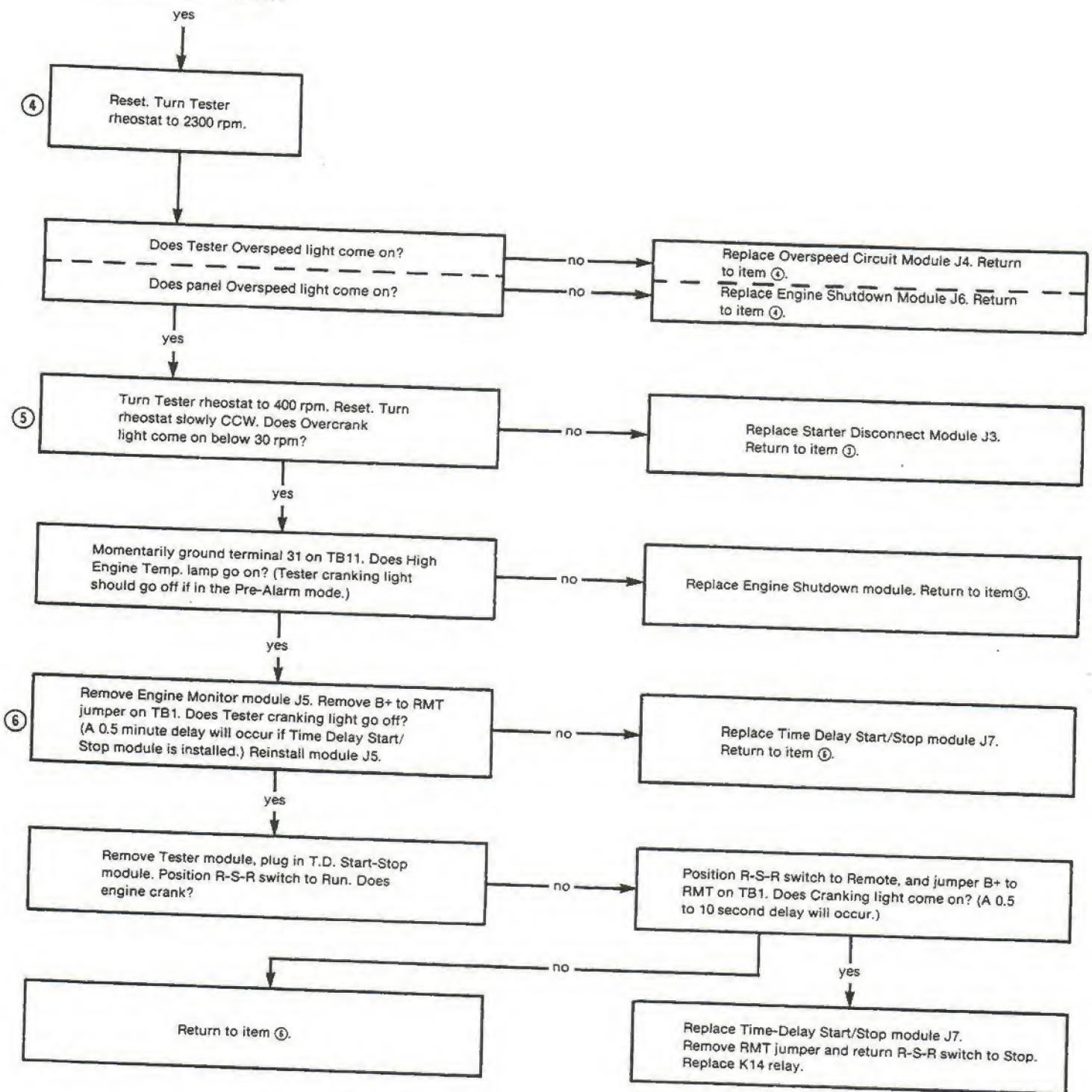
6. Place R-S-R switch S15 in RUN position (engine will not start).

## CHECKOUT

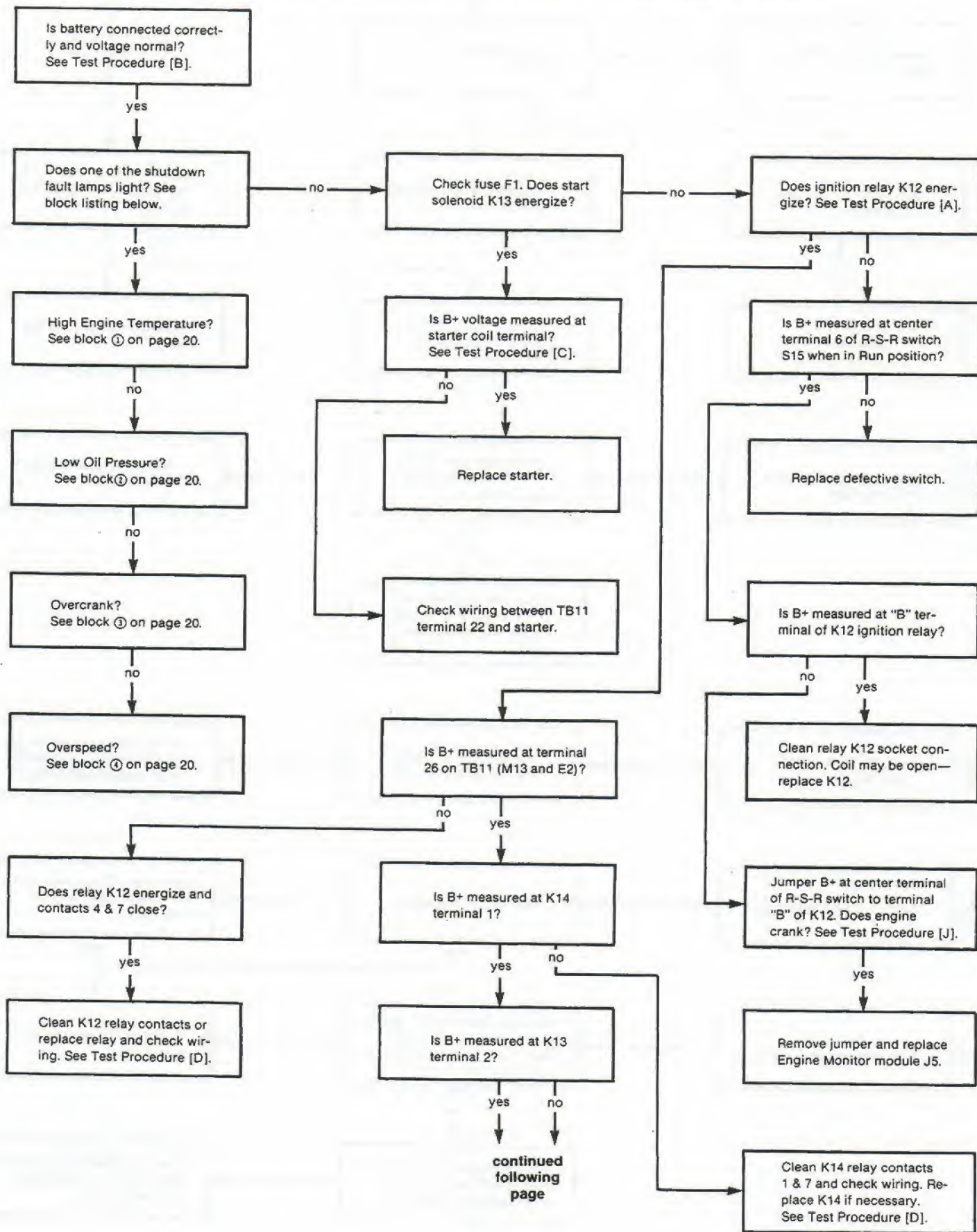




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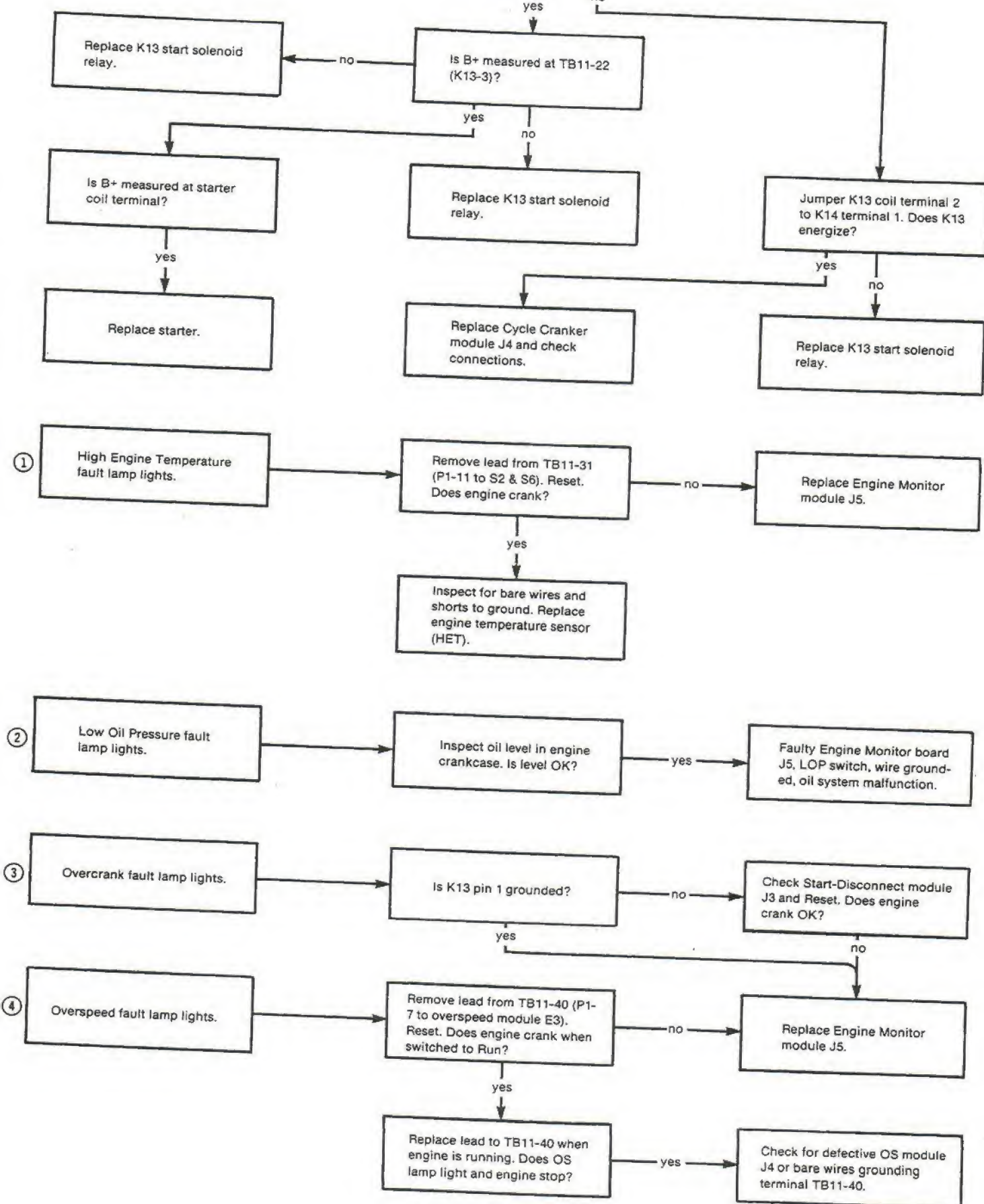


# FLOW CHART E. ENGINE FAILS TO CRANK. SWITCH IN RUN POSITION.





Continued from preceding page.



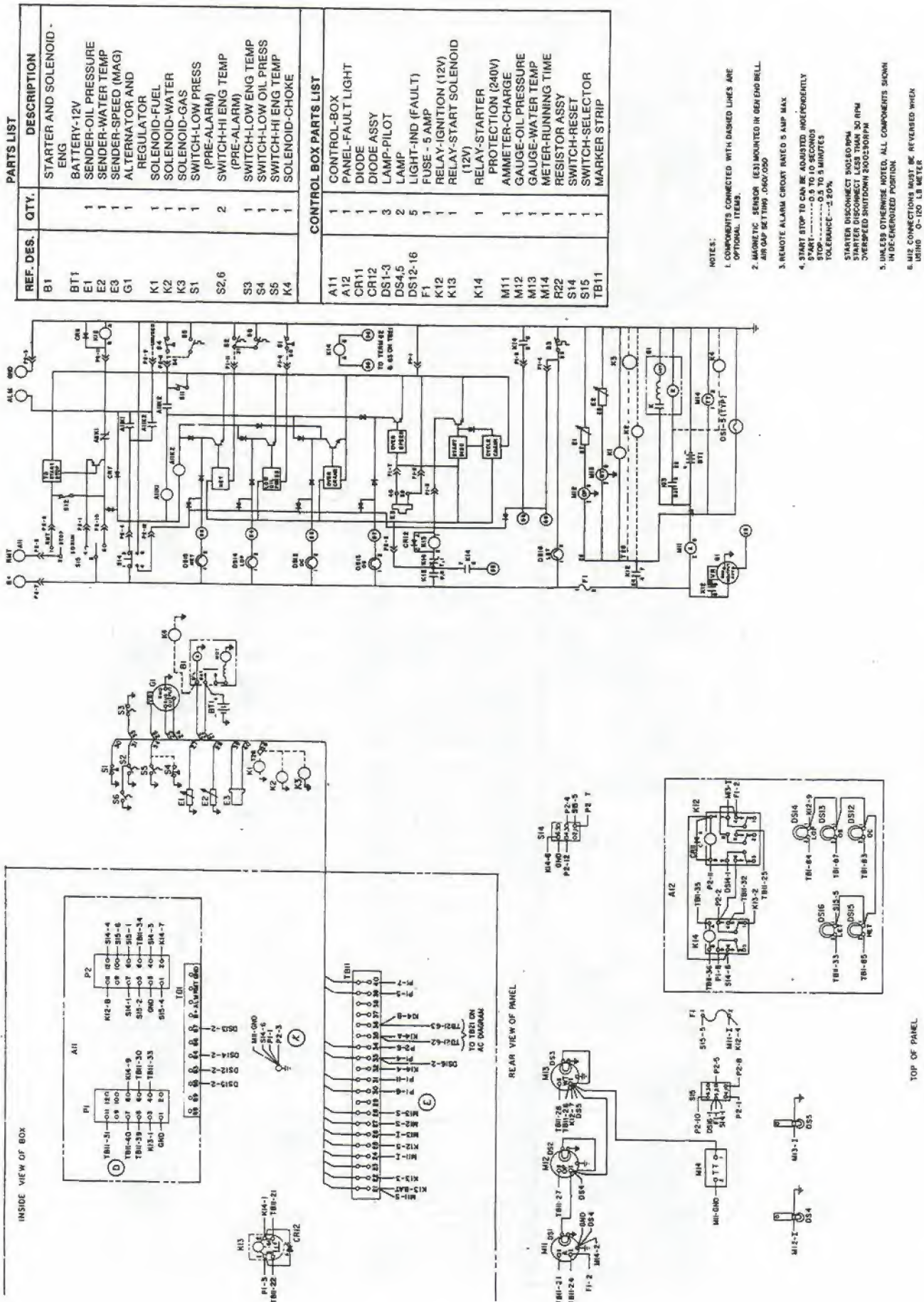
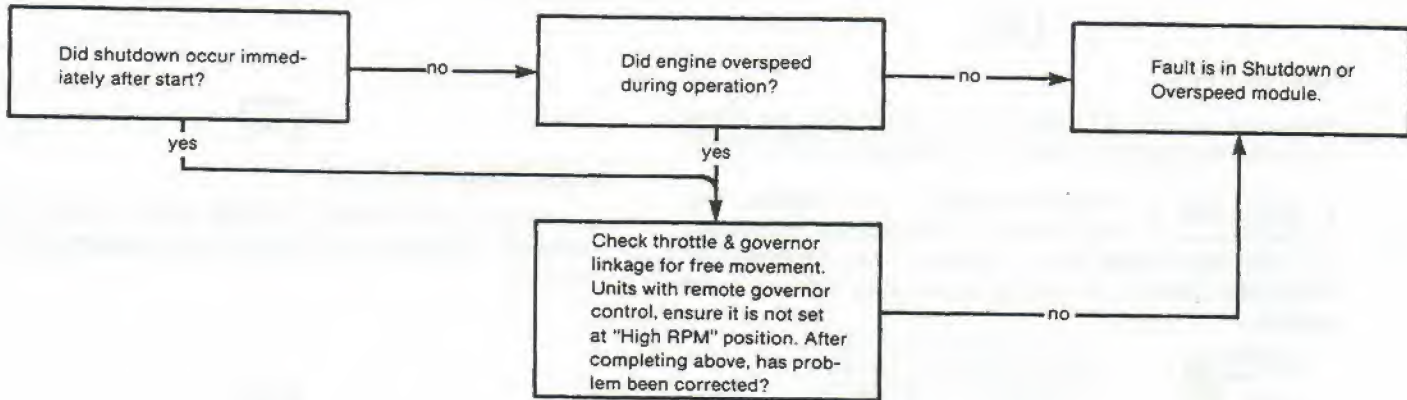


FIGURE 6. FIVE-LIGHT 12 VDC CONTROL SCHEMATIC AND WIRING DIAGRAM (612-5433)

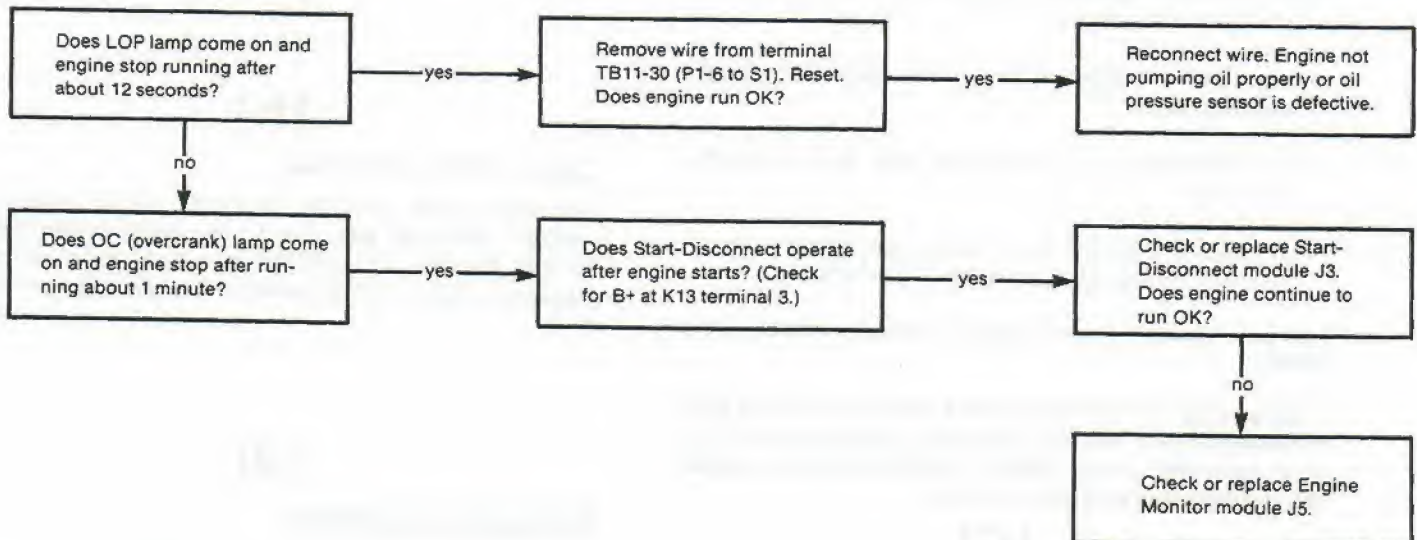




## FLOW CHART F. ENGINE MALFUNCTION SHUTDOWN, OVERSPEED LIGHT ON.



## FLOW CHART G. ENGINE SHUTS DOWN AFTER RUNNING SHORT TIME.





## TEST PROCEDURES

The following procedures provide for component checks on the most common sources of trouble.

### [A]

#### Starter Relay

Relays K11 and K12 are interchangeable, so either one can be used to check the operation of the other.

**CAUTION** *If starter fails to disengage, the engine may drive starter to unsafe speeds that could cause starter rotor windings to separate. Check start-disconnect relay K11 coil and socket.*

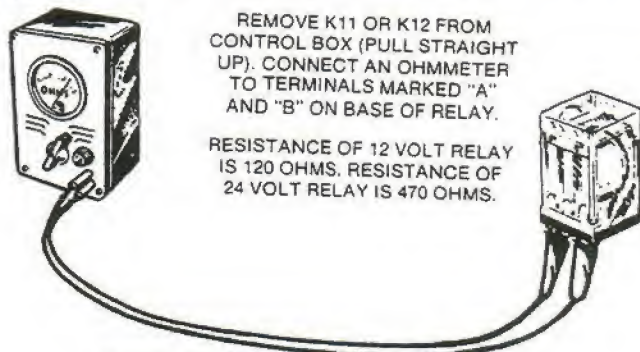


FIGURE 8. TEST K11 and K12 RELAYS

### [B]

#### Battery Cables

When connecting battery cables, terminal will spark if connection is reversed.

- Unit will not crank with reversed cables or loose connections.
- DC alternator will overheat and will probably burn up.
- A reverse battery connection will show a maximum positive charge on the DC ammeter.

On dry charged batteries, no voltage is present until electrolyte is added.

**WARNING** *Do not smoke while servicing batteries. Explosive gases are emitted from batteries in operation. Ignition of these gases can cause severe personal injury.*

### [C]

#### Starter Voltage

Check for voltage from starter terminals to ground. Voltage should be present at both terminals when solenoid is energized for cranking.

### [D]

#### Relay Check

Inspect contacts for dirt particles, obstructions or insulating film. Clean, using low pressure compressed air and bond paper. Check relay socket.

### [E]

#### N.C. Relay Contacts

Contacts are normally closed when engine is not running. Contacts must open when engine is running normal.

### [F]

#### N.O. Relay Contacts

Contacts are normally open; contacts close for alarm condition. (The mechanical overspeed switch used on 1-light units has to be reset manually.)

### [G]

#### Starter Solenoid

Contacts may have welded closed or plunger may be stuck. Remove solenoid from circuit to test for proper operation.

### [H]

#### Cycle Cranker By-Pass

Remove cycle cranker printed circuit board and jumper terminal pin 3-5 to by-pass cycle cranker circuit. Switch S11 on the one-light monitor board bypasses the cycle cranker delay period for testing only.

### [J]

#### Emergency Operation

In an extreme emergency, engine may be operated without any safeties by removing engine monitor printed circuit board and connecting a jumper from B+ terminal of Run-Stop switch to terminal "B" on K12 relay; see Figures 4 and 6.



## ADJUSTMENTS

### Overspeed Sensor Adjustment (Five-Light)

Adjust magnetic pick-up sensor assembly as follows:

1. Manually rotate ring gear so one tooth is centered under sensor mounting hole, Figure 9.
2. Install sensor by turning it inward until pole face just touches the gear tooth.
3. Back sensor out 1/4 turn and tighten jam nut. The gap between sensor and gear teeth should be 0.010 to 0.020 inch (0.25 to 0.50 mm).

The overspeed sensor activates the shutdown circuit at 5000 hertz  $\pm$  300 Hz.

### Overspeed Switch (Single-Light)

The overspeed switch is set so contacts close at 2200 to 2250 rpm. If necessary, the speed range can be corrected by turning the adjusting screw, thereby changing the magnetic air gap (see Figure 9). The air gap must not be less than 0.005 inch (0.13 mm).

### One-Light OC, LOP, T.D. Switch S1

This switch is on the one-light Monitor module board. It sets the time delay for the overcrank and low oil pressure 75-second time delay circuit. Positioning to Off by-passes the 75-second time delay when testing the one-light control. See drawing 300-1695 and 625-1543, Figure 5.

### Five-Light OS, Adjustment

Resistor R12 on Overspeed/Cycle Cranker Module Board J4 is used to adjust the overspeed programmable timer chip for overspeed shutdown. See drawing 300-1586, Figure 10. Refer to the specifications for details.

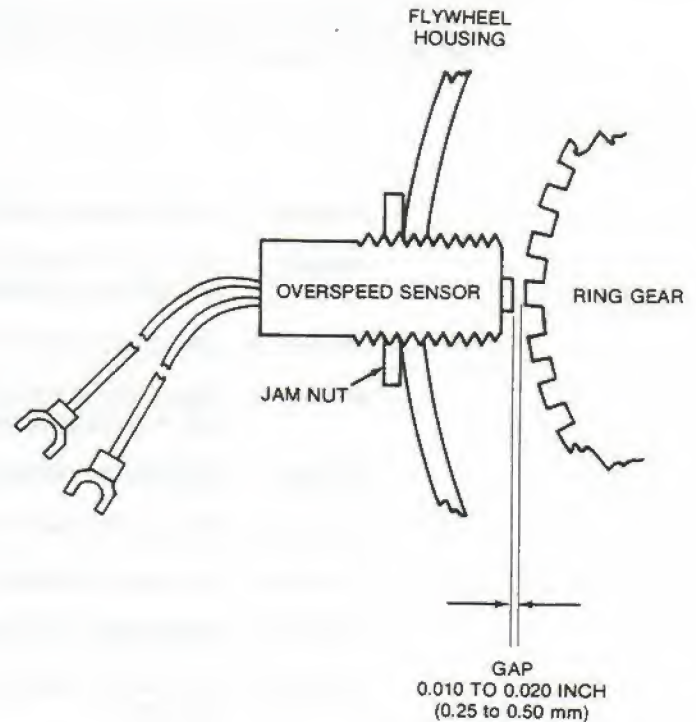
### Five-Light LOP, OC Dip Switch Adjustment

Switches S1, S2, S3, and S4 on Monitor Module J5 are used to set the time delay's overcrank delay circuit. See drawing 300-1587, Figure 11. Refer to the specifications and the time chart for details.

### Five-Light Start-Stop Dip Switch Adjustment

Switches S1 through S4 Time Delay Start and S5 through S8 Time Delay Stop are used to set time delay actions for operation and release delays. See drawing 300-2095, Figure 12. Refer to specifications and switch functions.

Use a pen or pencil for positioning these mini-rocker switches.



Magnetic Pickup has 5/8-18 Threads.

Turn in until pole face of pickup bottoms out on ring gear tooth and back out 1/4 turn and tighten jam nut.

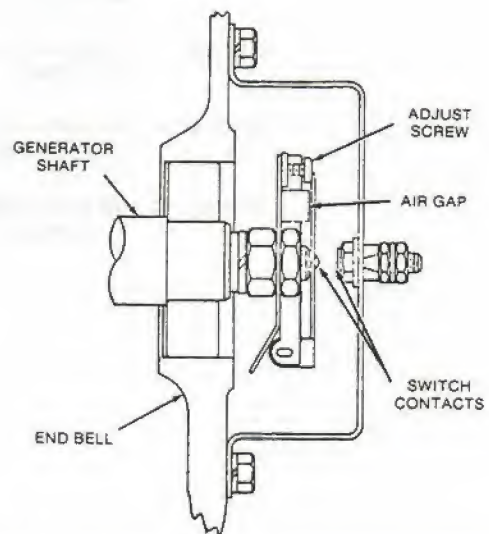


FIGURE 9. OVERSPEED SENSOR, OVERSPEED SWITCH



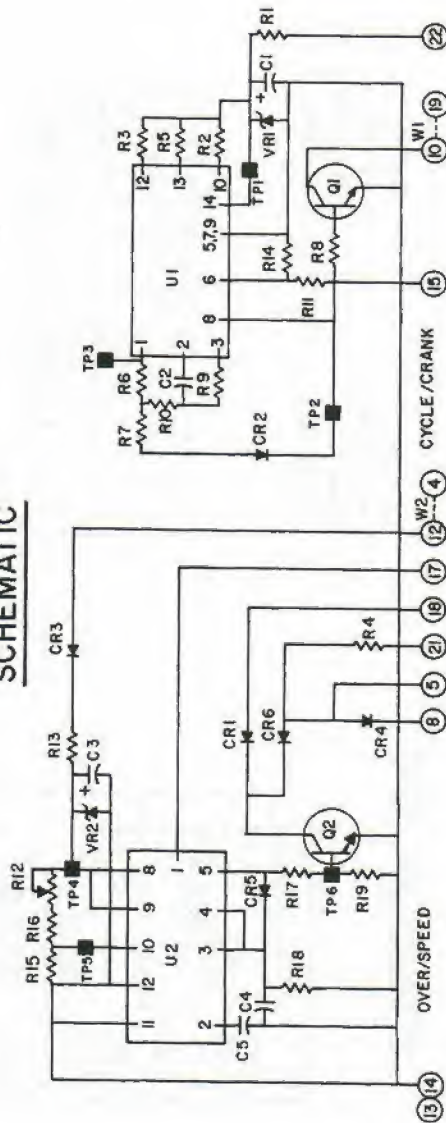
# Wiring Diagrams

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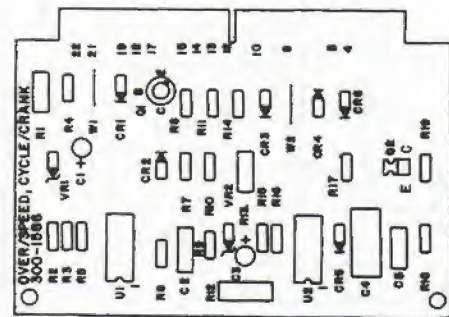
The electrical schematics and wiring diagrams listed below are applicable to the SK Series Engine and Generator Controls.

- FIGURE 3. 12 VDC ENGINE CONTROL SCHEMATICS
- FIGURE 4. ONE-LIGHT 12 VDC CONTROL SCHEMATIC AND WIRING DIAGRAMS (612-5473)
- FIGURE 5. ONE-LIGHT CONTROL—2 WIRE START (625-1543)
- FIGURE 6. FIVE-LIGHT 12 VDC CONTROL SCHEMATIC AND WIRING DIAGRAMS (612-5433)
- FIGURE 7. FIVE-LIGHT CONTROL—2 WIRE START (625-1542)
- FIGURE 10. FIVE-LIGHT CONTROL O/S, C/C MODULE J4 (300-1586)
- FIGURE 11. FIVE-LIGHT CONTROL MONITOR MODULE J5 (300-1587)
- FIGURE 12. FIVE-LIGHT CONTROL START-STOP MODULE J7 (300-2095)
- FIGURE 13. ONE-LIGHT CONTROL START-DISCONNECT, C/C MODULE J3 (300-1604)
- FIGURE 14. ONE-LIGHT CONTROL PANEL ASSEMBLY WIRING DIAGRAMS (300-1605)
- FIGURE 15. FIVE-LIGHT CONTROL CHASSIS (300-1590)
- FIGURE 16. FIVE-LIGHT CONTROL START-DISCONNECT MODULE J3 (300-1585)
- FIGURE 17. FIVE-LIGHT CONTROL SHUTDOWN MODULE J6 (300-1588)
- FIGURE 18. SK ONE-LIGHT 3-PHASE, 60 Hz AC CONTROL 12-WIRE RECONNECTABLE (612-5473 SHEET 1)
- FIGURE 19. SK FIVE-LIGHT 3-PHASE, 60 Hz AC CONTROL 12-WIRE RECONNECTABLE (612-5433 SHEET 1)

## SCHEMATIC



## MECHANICAL ASSY



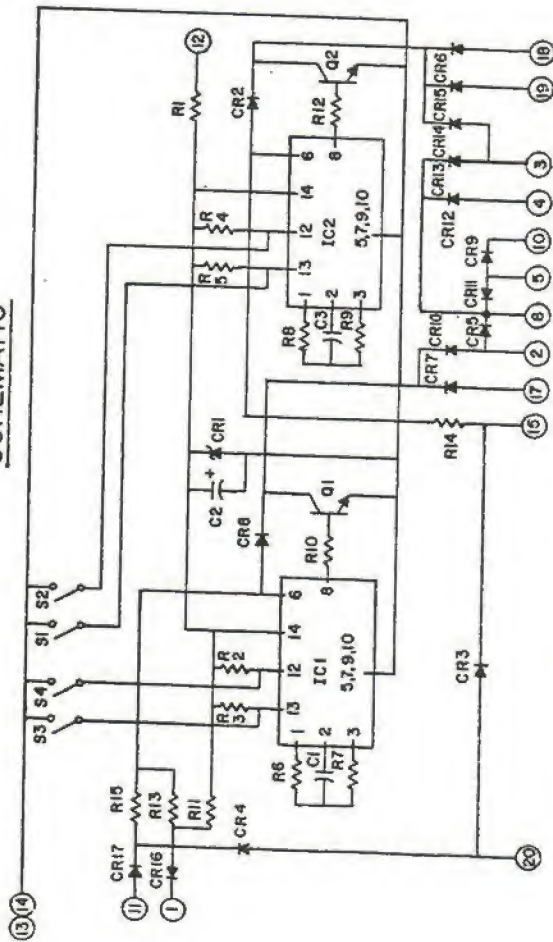
## SPECIFICATIONS

B+ POWER	12 ± 3 VDC
CRANK TIME	15 ± 4 SEC
REST TIME	10 ± 3 SEC
OVER SPEED	5K Hz ± 300
OUTPUT	CURRENT
PIN - 18	200 MA MAX
PIN - 5	200 MA MAX

REF. DES.	QTY.	DESCRIPTION
R1	1	RESISTOR - 220Ω, 1/2W, 5%
W1, W2	2	JUMPER - PC BD
U2	1	INTEGRATED CIRCUIT LM 2907
U1	1	INTEGRATED CIRCUIT PROGRAMMABLE TIMER
R12	1	POTENTIOMETER 50K, 1/4W, 5%
R4	1	RESISTOR - 100Ω, 1/4W, 5%
R10	1	RESISTOR - 38KΩ, 1/4W, 5%
R7	1	RESISTOR - 22KΩ, 1/4W, 5%
R16	1	RESISTOR - 47KΩ, 1/4W, 5%
R15, 18	2	RESISTOR - 88KΩ, 1/4W, 5%
R9	1	RESISTOR - 120KΩ, 1/4W, 5%
R6	1	RESISTOR - 13KΩ, 1/4W, 5%
R2, 3, 5, 8, 11, 14, 17, 19	8	RESISTOR - 10KΩ, 1/4W, 5%
R13	1	RESISTOR - 100Ω, 1/2W, 5%
Q2	1	TRANSISTOR PU 45A
Q1	1	TRANSISTOR 2N2222A (NPN)
CR1-6	6	DIODE 400 MA 400V
VR1	1	DIODE - ZENER 7.5V
VR2	1	DIODE - ZENER 13V
C1, 3	2	CAPACITOR TANTALUM 6.8 MFD 35V
C4	1	CAPACITOR COMPOSITION 1.0 MFD 100V
C5	1	CAPACITOR COMPOSITION .0015 MFD 630V
C2	1	CAPACITOR COMPOSITION .0033 MFD 1000V



# SCHEMATIC



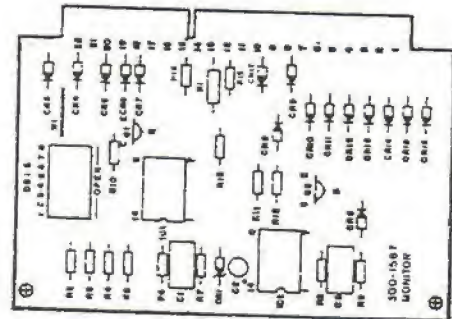
## PARTS LIST

REF. DES.	QTY.	DESCRIPTION
R15	1	RESISTOR - 2000Ω, 1/4W, 5%
R7,9	2	RESISTOR - 120K, 1/4W, 5%
R6,8	2	RESISTOR - 58K, 1/4W, 5%
R2-5,	9	RESISTOR - 10KΩ, 1/4W, 5%
R1	1	RESISTOR - 100Ω, 1/2W, 5%
DS1-8	1	SWITCH ROCKER DIP
CR2-17	16	DIODE - 400 MA 400V
CR1	1	DIODE - ZENER 13V
Q1,Q2	2	TRANSISTOR PU 45A
IC1,IC2	2	INTEGRATED CIRCUIT
C3	1	PROGRAMMABLE TIMER
C2	1	CAPACITOR COMPOSITION
C1	1	-.15 MFD/100V
		6.8 MFD/35V
		-.022 MFD/400V

## SPECIFICATIONS

B+ POWER	-----	12 ± 3 VDC
LOW OIL PRESS DELAY	-----	10 ± 2 SEC
OVER CRANK DELAY	-----	75 ± 10 SEC
STORAGE TEMP	-----	-40°C TO 100°C
OPERATING TEMP	-----	-20°C TO 80°C

## MECHANICAL ASSY

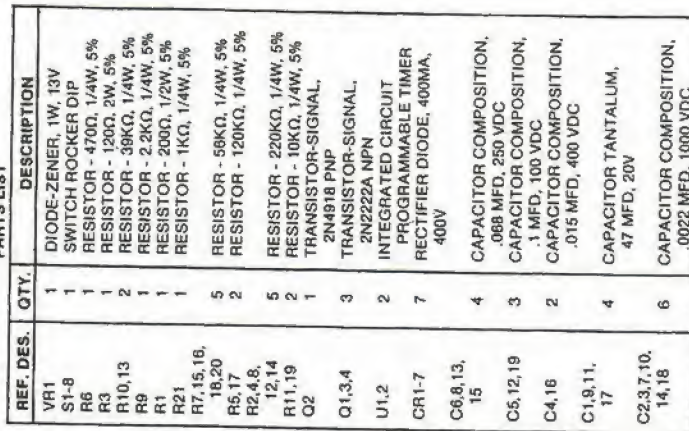


4	3	IC1	2	1	IC2
C	C	10 SEC	C	C	75 SEC
C	O	1.25 SEC	C	O	9.4 SEC
O	C	.3 SEC	O	C	2.2 SEC
O	O	800 SEC	O	O	600 SEC

NOTE:  
C IS CLOSED  
O IS OPEN

FIGURE 11. FIVE-LIGHT CONTROL MONITOR MODULE J5 (300-1587)

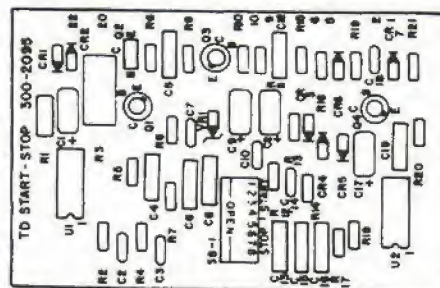
## PARTS LIST



## SPECIFICATIONS

INPUT	10 TO 15 VDC
LOAD CURRENT	400 MA
TIMING ACTION	
DELAY ON OPERATE	20° TO 45°C
DELAY ON RELEASE	65° TO 75°C
TEMPERATURE	
OPERATE	20° TO 45°C
STORAGE	65° TO 75°C
REVERSE POLARITY ON	
TO START SECTION	

		TIME	T.D. START	T.D. STOP
		HOUR MIN SEC	1 2 3 4	5 6 7 8
1		.5	0 0 C 0	C 0 0 0
2			1 0 0 0	C 0 C 0
3		1.5	0 C 0 0	C 0 0 C
4		2.5	C C 0 0	C 0 C C
5		5.5	0 C 0 C	C 0 C C
6		8	0 0 0 0	0 0 0 C
7		9.5	C 0 C 0	C C C 0
8			0 C 0 0	0 0 0 C
9	1	2	0 0 C 0	C C 0 0
10	1	16	C 0 0 0	0 0 C C
11	5	43	C C C C	C C C C
12	15		C C C C	C C C C



START | STOP

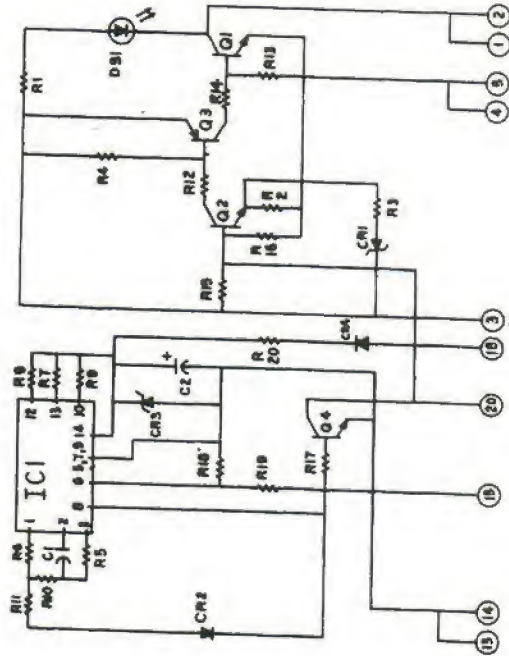
1	2	3	4	5	6	7	8
---	---	---	---	---	---	---	---

— OPEN —

FIGURE 12. FIVE-LIGHT CONTROL START-STOP MODULE J7 (300-2095)

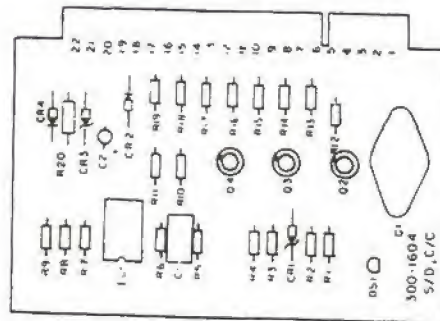


# **SCHEMATIC DIAGRAM**



REF. DES.	QTY.	DESCRIPTION
IC1	1	IC-PROGRAMMABLE
R20	1	TIMER
R15,16	2	RESISTOR - 100Ω, 1/2W, 5%
R12	1	RESISTOR - 1KΩ, 1/4W, 5%
R11	1	RESISTOR - 2KΩ, 1/4W, 5%
R10	1	RESISTOR - 22KΩ, 1/4W, 5%
R8	1	RESISTOR - 38KΩ, 1/4W, 5%
R5	1	RESISTOR - 13KΩ, 1/4W, 5%
R4, 7-9	1	RESISTOR - 120KΩ, 1/4W, 5%
13,17-19	8	RESISTOR - 10KΩ, 1/4W, 5%
R2,14	2	RESISTOR - 200Ω, 1/4W, 5%
R1,3	2	RESISTOR - 510Ω, 1/4W, 5%
Q3	1	TRANSISTOR - 2N2807A
Q2,4	2	TRANSISTOR - 2N2222A
Q1	1	TRANSISTOR - 2N3684
CR3	1	DIODE - ZENER 7.5V
CR2,4	2	DIODE - ZENER 5.1V
CR1	1	DIODE - 400 MA 4.00V
DS1	1	LAMP - LED (RED)
C2	1	CAPACITOR TANTALUM
C1	1	6.8 MFD 35V
		CAPACITOR COMPOSITION
		.0033 MFD 1000V

## **MECHANICAL ASSY**

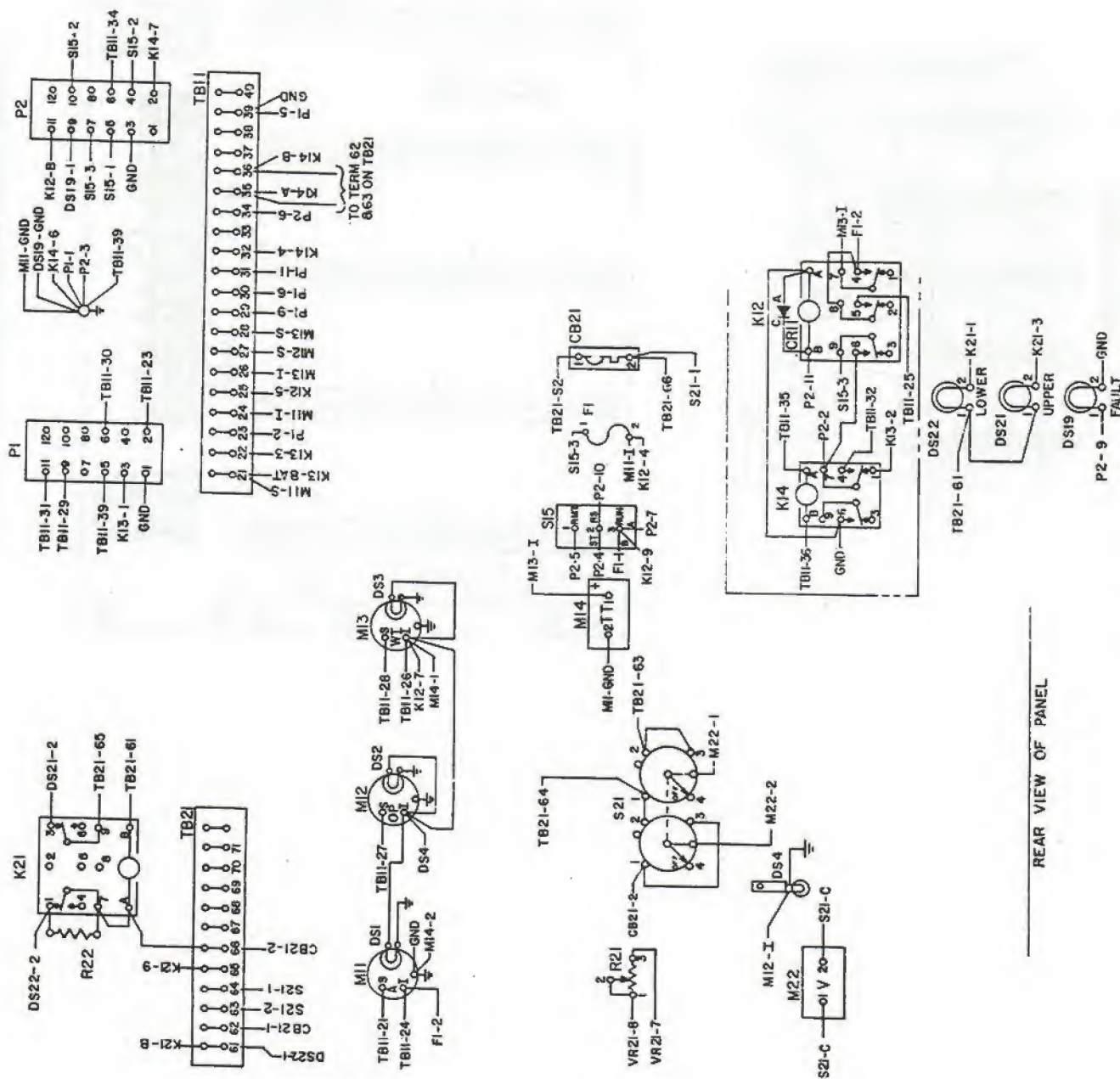


## **SPECIFICATIONS**

5+ POWER	12 ± 3 VDC
LOAD CURRENT	2 AMPS MAX
LOAD VOLTAGE	15 VOLTS
STORAGE TEMPERATURE	-40°C TO 80°C
OPERATING TEMPERATURE	-20°C TO 89°C
CRANK TIME	15 ± 4 SEC
REST TIME	10 ± 3 SEC

**FIGURE 13. ONE-LIGHT CONTROL START-DISCONNECT, C/C MODULE J3  
(300-1604)**

REF. DES.	QTY.	DESCRIPTION
DS1,2&3	3	LAMP-PILOT
DS4	1	LAMP
S21	1	SWITCH & LEAD ASSY
S15	1	SWITCH-SELECTOR
R21	1	RHEOSTAT-VOLTAGE
	1	ADJUST 35K.25W
M22	1	VOLTMETER-AC 0-300.0-600
M14	1	METER-RUNNING TIME
M13	1	GAUGE-WATER TEMP
M12	1	GAUGE-OIL PRESS
M11	1	AMMETER-CHARGE
F1	1	FUSE-5 AMP
DS22	1	LIGHT-IND (LOWER)
DS21	1	LIGHT-IND (UPPER)
DS19	1	LIGHT-IND (FAULT)
CB21	1	CIRCUIT BREAKER, 2 AMP





# PARTS LIST

REF. DES.	QTY.	DESCRIPTION
C1,C2	2	CAPACITOR-ELECTROLYTIC 180 MFD 40V
S1,S12	2	SWITCH - SLIDE
TB1	1	TERMINAL BLOCK - PC BD
J3-J7	5	HOUSING - PC BD TERM
J1,J2	2	CONNECTOR - RECEPTACLE

SCHEMATIC DIAGRAM

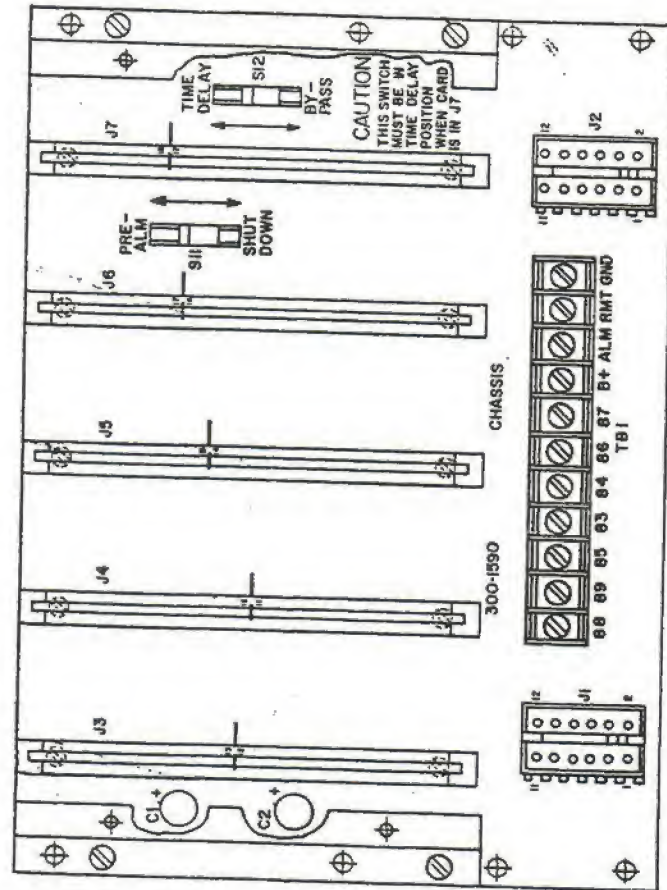
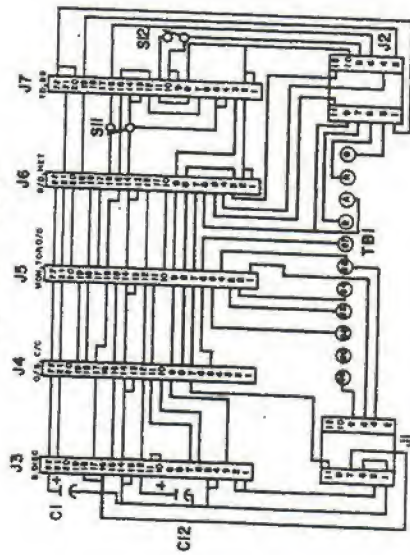
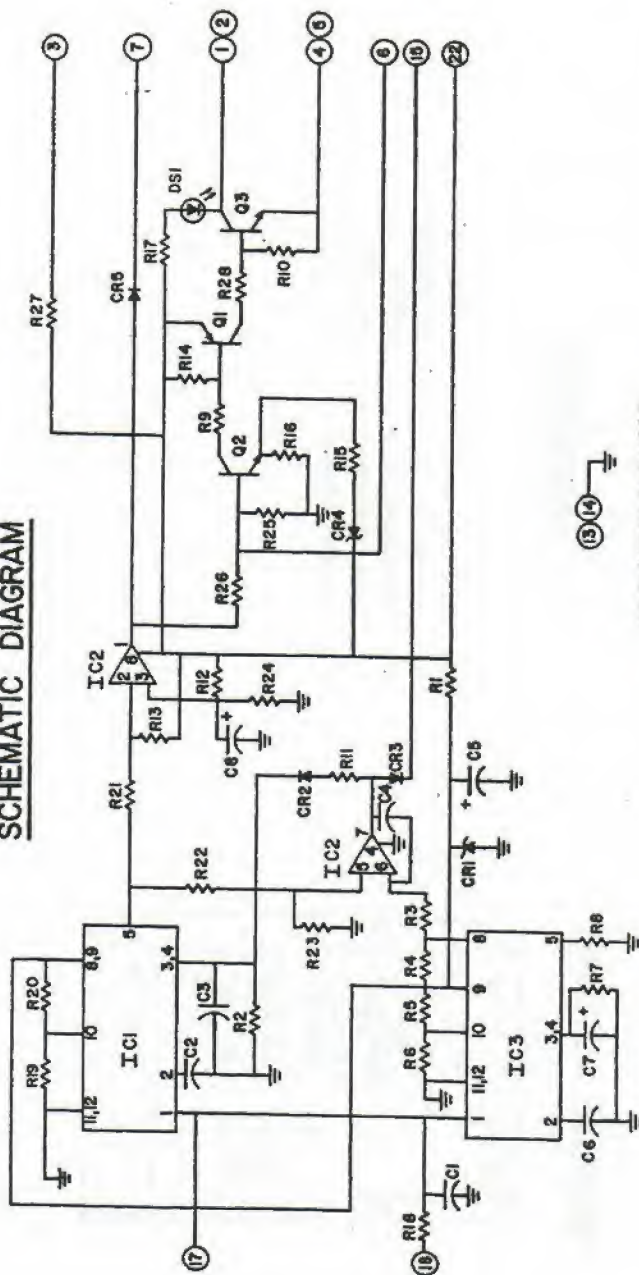
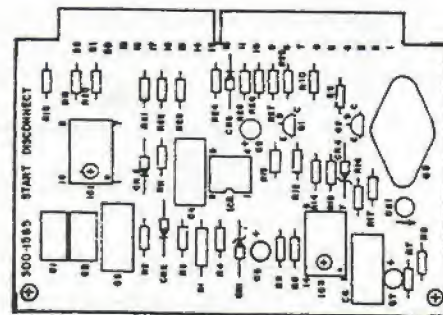


FIGURE 15. FIVE-LIGHT CONTROL CHASSIS (300-1590)

# SCHEMATIC DIAGRAM



# MECHANICAL ASSY



# SPECIFICATIONS

INPUT VOLTAGE	1 TO 12 VDC
INPUT FREQUENCY	0 TO 3 KC
B+ POWER	12 ± 3 VDC
LOAD CURRENT	2 AMPS MAX
LOAD VOLTAGE	15 VOLTS
STORAGE TEMPERATURE	-40° C TO 100° C
OPERATING TEMPERATURE	-20° C TO 100° C
DISCONNECT FREQUENCY	1500 ± 250 Hz
RECONNECT FREQUENCY	50 ± 50 Hz

# PARTS LIST

REF. DES.	QTY.	DESCRIPTION
R25,26	2	RESISTOR - 1KΩ, 1/4W, 5%
R18	1	RESISTOR - 100Ω, 1/4W, 5%
R16,28	2	RESISTOR - 200Ω, 1/4W, 5%
R15,17	2	RESISTOR - 510KΩ, 1/4W, 5%
R13	1	RESISTOR - 1MΩ, 1/4W, 5%
R12,21,24	3	RESISTOR - 200KΩ, 1/4W, 5%
R11	1	RESISTOR - 20KΩ, 1/4W, 5%
R9	1	RESISTOR - 2KΩ, 1/4W, 5%
R5,6,8,19,20	5	RESISTOR - 5100Ω, 1/4W, 5%
R3,4,14	6	RESISTOR - 10KΩ, 1/4W, 5%
R2,7,23	3	RESISTOR - 100KΩ, 1/4W, 5%
R1	1	RESISTOR - 100Ω, 1/2W, 5%
CR4	1	DIODE - ZENER 5.1V
CR2,3,5	3	DIODE - 400 MA 400V
CR1	1	DIODE - ZENER 13V
Q3	1	TRANSISTOR 2N 3584
Q2	1	TRANSISTOR MPS 6530
Q1	1	TRANSISTOR MPS 6533
IC2	1	INTEGRATED CIRCUIT DUAL OP AMP
IC1,3	2	INTEGRATED CIRCUIT - LM 2907
DS1	1	LAMP - LED (RED)
C6	1	CAPACITOR COMPOSITION 1 MFD/100V
C5,7,8	3	CAPACITOR TANTALUM 6.8 MFD/35V
C3,4	2	CAPACITOR COMPOSITION .1 MFD/400V
C1,2	2	CAPACITOR COMPOSITION .0033 MFD/1000V

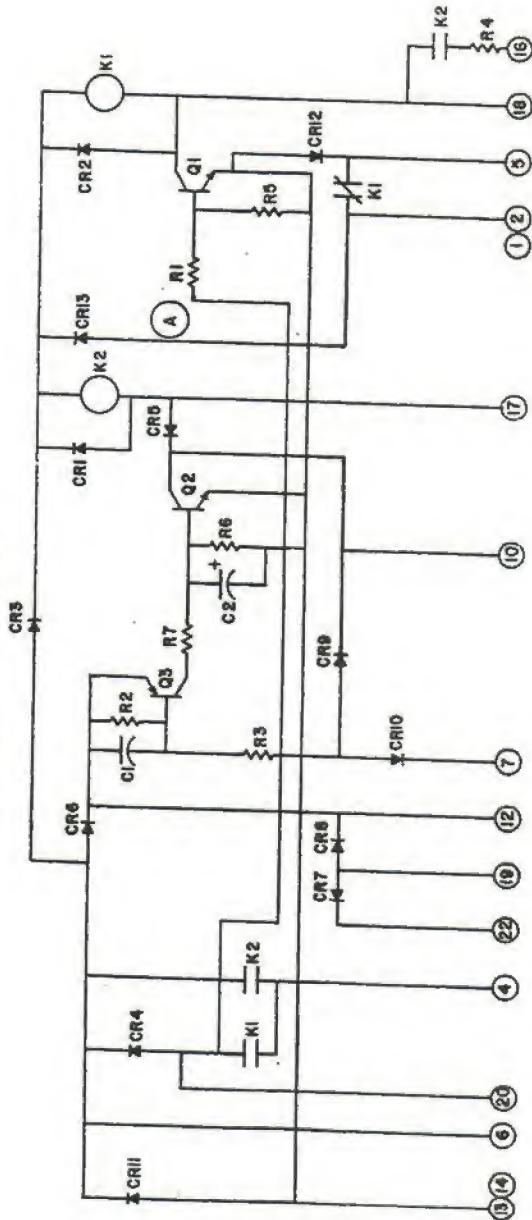
FIGURE 16. FIVE-LIGHT CONTROL START-DISCONNECT MODULE J3 (300-1585)



# SCHEMATIC DIAGRAM

## PARTS LIST

REF. DES.	QTY.	DESCRIPTION
R7	1	RESISTOR - 3K $\Omega$ , 1 4W, 5%
R5,6	2	RESISTOR - 10K $\Omega$ , 1 4W, 5%
R4	1	RESISTOR - 10K $\Omega$ , 1 4W, 5%
R3	1	RESISTOR - 10K $\Omega$ , 1 4W, 5%
R2	1	RESISTOR - 2200 $\Omega$ , 1 4W, 5%
R1	1	RESISTOR - 270 $\Omega$ , 1 4W, 5%
Q3	1	TRANSISTOR MPS 6533
Q2	1	TRANSISTOR PU 45A
Q1	1	TRANSISTOR MPS 6530
K1,2	2	RELAY
CR4	1	RECTIFYING DIODE 3 AMPS
CR1-3, 5-13	13	RECTIFYING DIODE 400MA 400V
C2	1	CAPACITOR TANTALUM 6.8 MFD 35V
C1	1	CAPACITOR COMPOSITION .1 MFD 400V



## SPECIFICATIONS

INPUT	----- 12 VDC $\pm$ 3 VDC
RELAY PULL IN	----- LESS THAN 0 VDC
OUTPUT CURRENT P1H	----- 3 AMPS MAX
STORAGE TEMPERATURE	----- -40°C TO 60°C
OPERATING TEMPERATURE	----- -20°C TO 60°C

## MECHANICAL ASSEMBLY

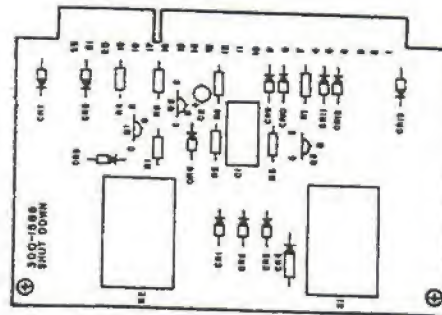
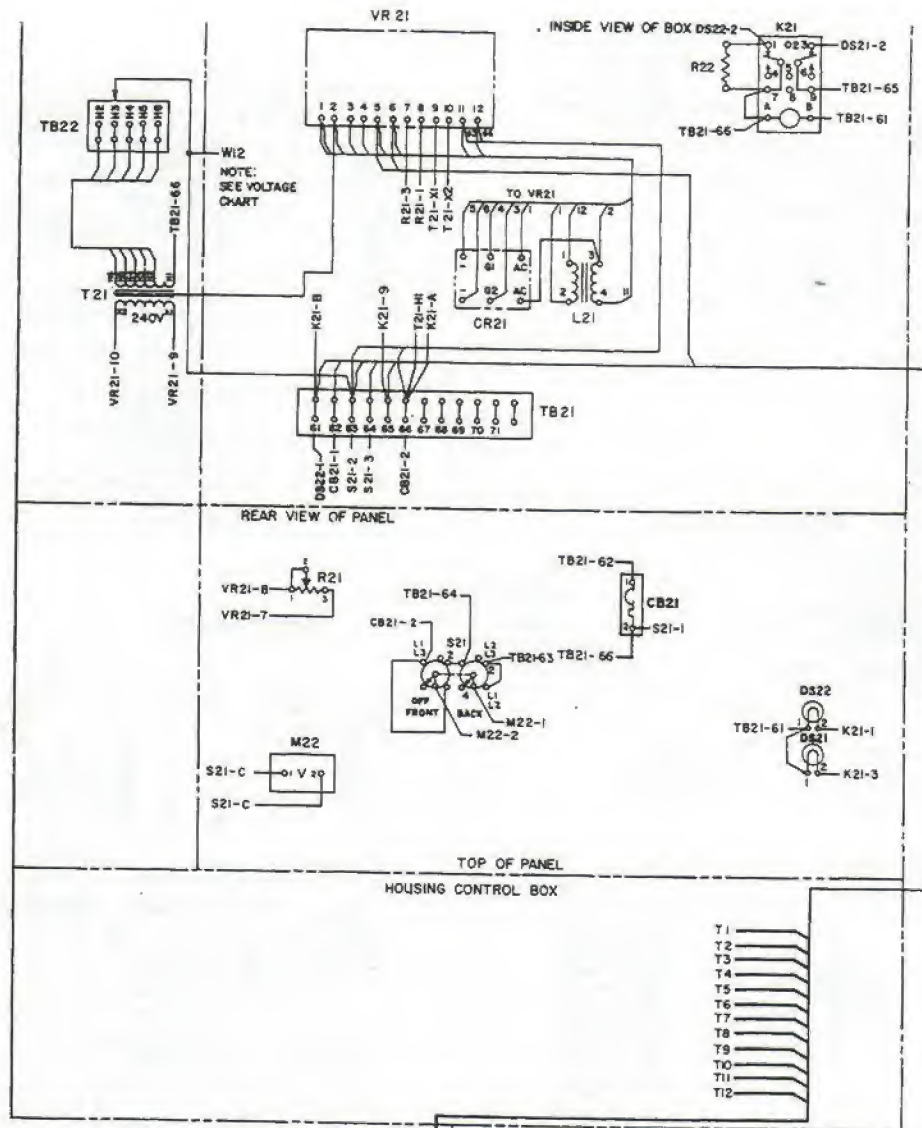
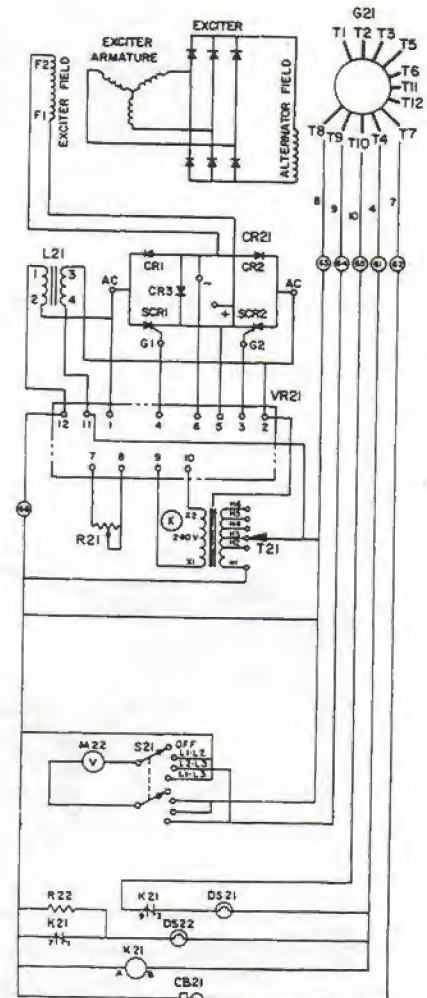


FIGURE 17. FIVE-LIGHT CONTROL SHUTDOWN MODULE J6  
(300-1588)



PARTS LIST		
REF. DES.	QTY.	DESCRIPTION
CB21	1	CIRCUIT BREAKER, 2 AMP
CR21	1	RECTIFIER BRIDGE
DS21	1	LIGHT-IND (UPPER)
DS22	1	LIGHT-IND (LOWER)
G1	1	GENERATOR
K21	1	RELAY-VOLTAGE SELECTOR
L21	1	REACTOR ASSY COMM
M22	1	VOLTMETER-AC, 0-300, 0-600
R21	1	RHEOSTAT-VOLTAGE ADJ 3.5K, 25W
R22	1	RESISTOR 47,000Ω, 1/2 WATT
S21	1	SWITCH-VOLT AND AMMETER
T21	1	TRANSFORMER-VOLT
TB21	1	MARKER STRIP
TB22	1	MARKER STRIP
VR21	1	BOARD ASSY-PC, VOLTAGE RGLTR
W12	1	LEAD ASSY

#### SCHEMATIC DIAGRAM



NOTE:  
CONNECT LEAD W12 FROM  
TERMINAL TB21-63 TO TB22-(H...) PER VOLTAGE CHART BELOW

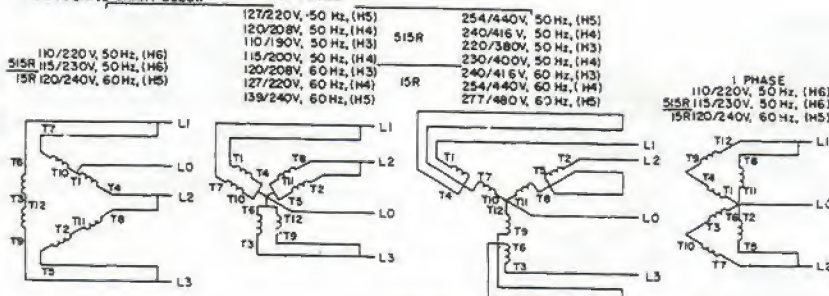
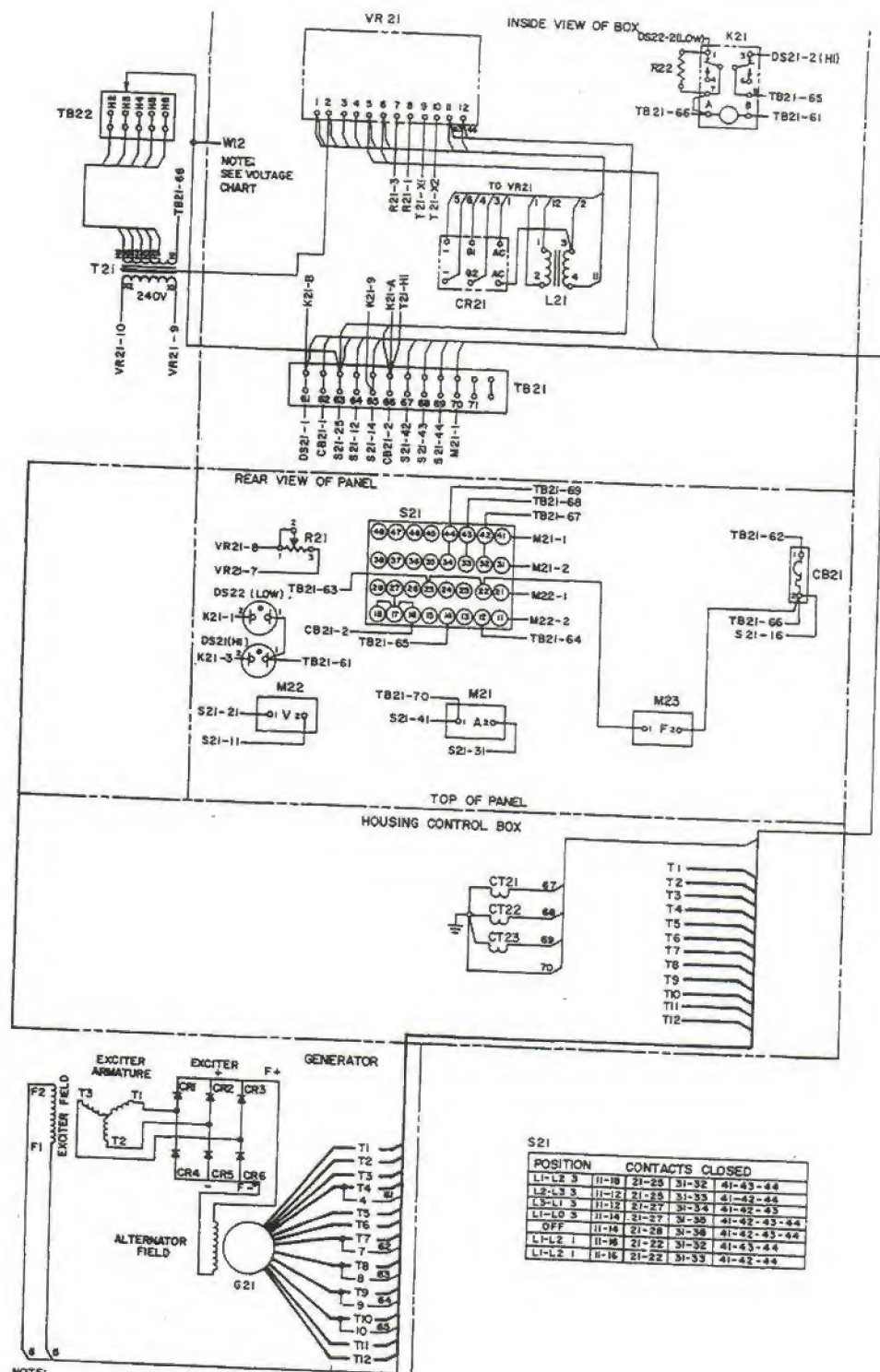


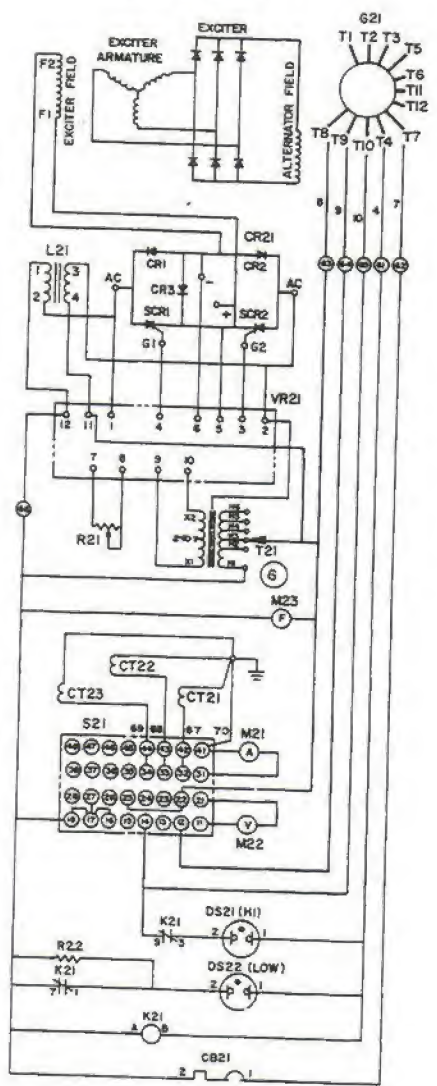
FIGURE 18. SK ONE-LIGHT 3-PHASE, 60 Hz AC CONTROL  
12-WIRE RECONNECTABLE (612-5473 SHEET 1)





PARTS LIST		
REF. DES.	QTY.	DESCRIPTION
CB21	1	CIRCUIT BREAKER, 2 AMP
CT21,23	1	TRANSFORMER ASSY - CUR
CR21	1	RECTIFIER BRIDGE
DS21&22	2	LIGHT-PILOT, 3W 125V
G1	1	GENERATOR
K21	1	RELAY-VOLTAGE SELECTOR
L21	1	REACTOR ASSY COMM
M21	1	AMMETER-AC
M22	1	VOLTMETER-AC
M23	1	METER-FREQUENCY
R21	1	RHEOSTAT-VOLTAGE ADJ 3.5K, 25W
R22	1	RESISTOR-FIXED CMPSN, 47000Ω, 125V
S21	1	SWITCH-VOLT AND AMMETER
T21	1	TRANSFORMER-VOLT
TB21	1	MARKER STRIP
TB22	1	MARKER STRIP
VR21	1	BOARD ASSY-PC VOLTAGE
W12	1	LEAD ASSY

SCHEMATIC DIAGRAM



POSITION	CONTACTS CLOSED
L1-L2 3	11-18 21-25 31-32 41-43-44
L2-L3 3	11-12 21-25 31-33 41-42-44
L3-L1 3	11-12 21-27 31-34 41-42-43
L1-L0 3	11-14 21-27 31-35 41-42-43-44
OFF	11-14 21-28 31-35 41-42-43-44
L1-L2 1	11-16 21-22 31-32 41-43-44
L1-L2 1	11-16 21-22 31-33 41-42-44

NOTE: CONNECT LEAD W12 FROM TERMINAL TB21-63 TO TB22-(H-) 3 PHASE VOLTAGE CONNECTIONS PER VOLTAGE CHART BELOW

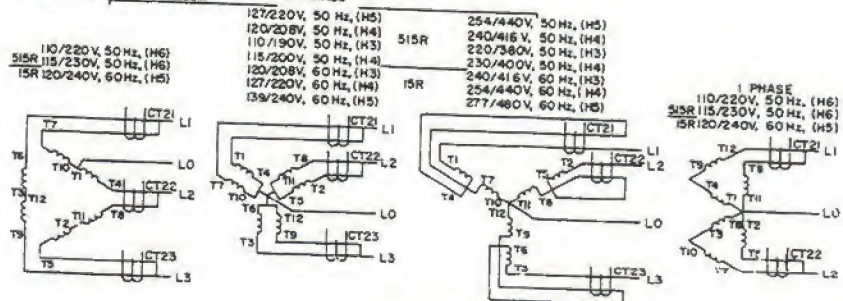


FIGURE 19. SK FIVE-LIGHT 3-PHASE, 60 Hz AC CONTROL 12-WIRE RECONNECTABLE (612-5433 SHEET 1)